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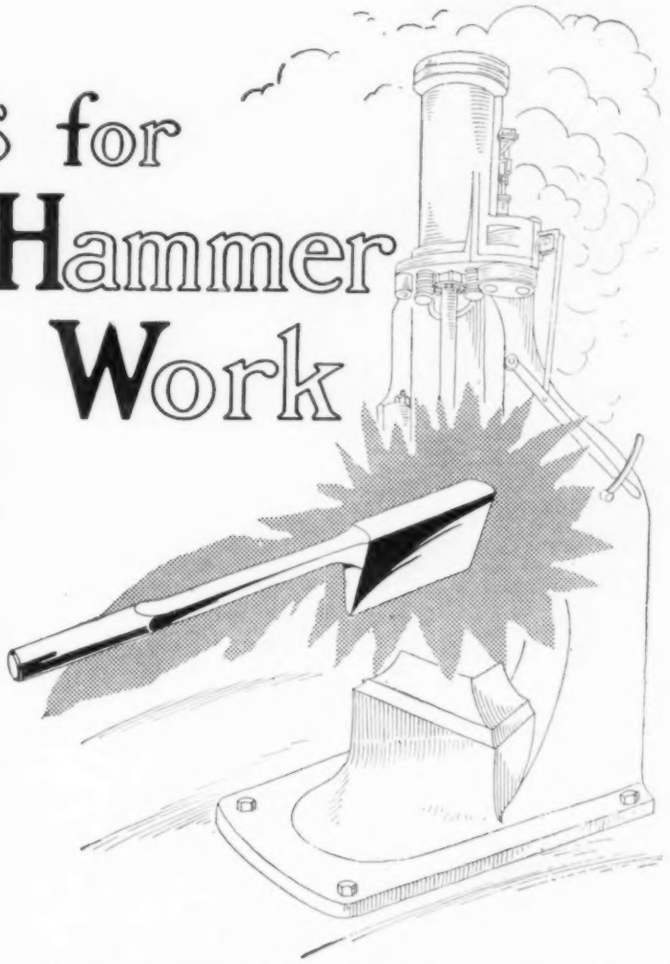
Hand Tools for Steam Hammer Work

By A. S. Hesse



The modern steam hammer is no exception to the general rule that a machine must be equipped with the proper tools to have it of the greatest service in its own field. The author takes up here the details of design and methods of using those of the necessary tools which are in most common use with the steam hammer.

THE steam hammer is responsible for the development of the modern forge shop. Such work as squaring, flattening, rounding, drawing, cutting, punching, upsetting and squeezing are readily performed under the steam hammer, and when the proper tools are provided other operations can be added, as flanging, pressing, stamping, bending, shearing, drop forging, etc., much of this auxiliary equipment being described in the subjoined remarks.

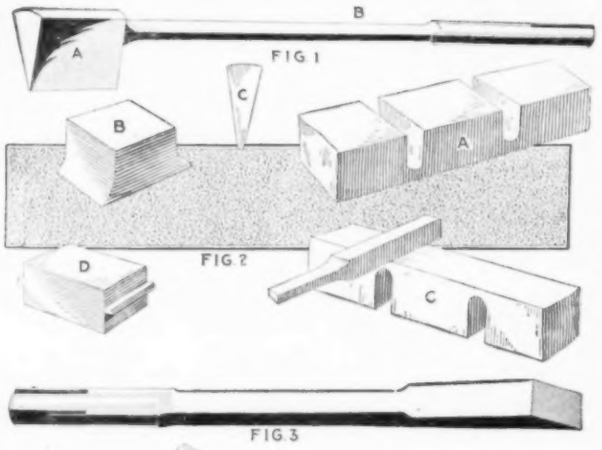
Cutting Tools

Cutters should be the first tools to be made for a hammer. Five or six are none too many for each hammer, and generally there should be duplicates of the more important ones in case of breakage. They should be narrow, wide, thin and thick, light and heavy, according to the size of the hammer and the work to be done. They should be made of steel with 0.50 to 0.75 carbon. The advantage of the higher carbon steel lies in its stiffness and ability to stand up when working hot material. The general form of cutters is similar to that indicated in Fig. 1, where the head *A* is the active, or cutting, portion. The thin part of the handle *B* should be at least two and one-half or three times the length of the blade and thin enough to take up any jar before it reaches the hammersmith's hands; it also prevents breakage of the handle. The cutting edge of the blade should be dressed square, as indicated at *C*, and never sharp nor round.

When cutting off large rounds the cut is started with a thin cutter, followed by a large, thick cutter which will upset the end of the stock and not pull it down or flatten it. In cutting round bars work around the full circumference of the bar with small cuts until a notch surrounds the bar. From this work toward the center; never driving the cutter through from one side.

When cutting square or flat bars, if the cut is driven through from one side, as shown at *A*, Fig. 2, the work will have a feather edge, as shown at *B*. In order to avoid this the square-edge cutter, Fig. 3, is used, as indicated at *C*, Fig. 2. This frequently leaves the piece with a small fin as at *D*, which can readily be removed with a hot chisel and sledge Cutters should be cooled frequently when making deep cuts. Where the hammersmith has duplicate chisels he will often remove one from a cut, plunge it in the tank for cooling, while he uses another. A quenching tank, say 18 in. in diameter by 30 in. deep, is a useful adjunct to a hammer. Small bars can be nicked and broken cold very quickly. The nicking chisel at *A*, Fig. 4, is suitable for this purpose, but the one shown at *B* is the best and most commonly used. They should be made of tool steel hardened and tempered; the work is shown at *C*.

The shearing tool illustrated in Fig. 5 consists of two pieces, *A* and *B*, made of tool steel with edges ground square. They are placed on opposite sides of the stock to be cut, as indicated at *C*, care being used to get the two cutting edges vertically in line with one another, so that they will clear when the blow is struck. When a round bar is to be cut the shear blocks shown at *D* and *E* are used. The block *D* is placed on the hammer anvil, the bar laid in the groove and the block *E* placed above it, similar to the operation performed with *A* and *B*. Even with great caution this method of cutting is dangerous. The hammerman must use judgment in striking hard enough to shear or



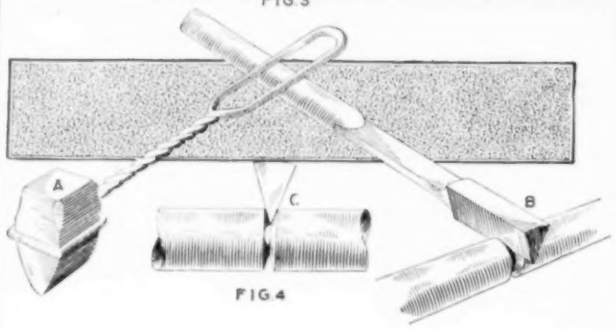
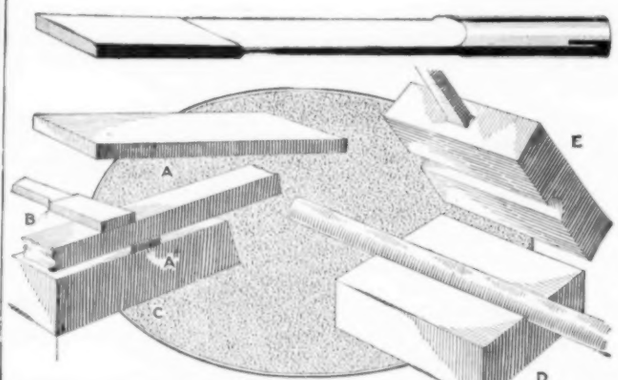
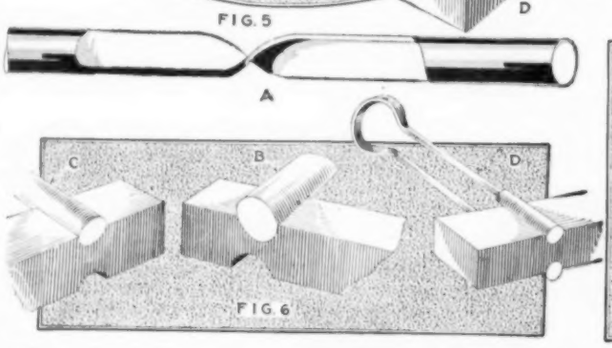
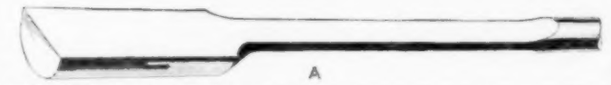
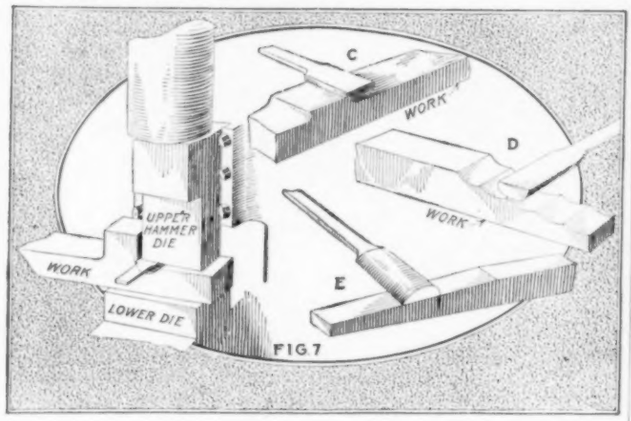


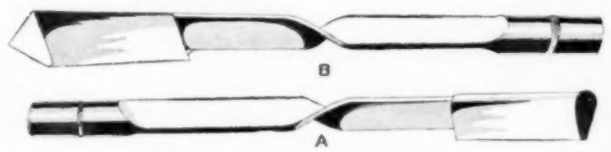
Fig. 1—The usual form of cutter. Fig. 2—The cut should not be made from one side. Fig. 3—Another form of cutter. Fig. 4—Other forms and manner of using them. Fig. 5—Shearing tools for flat and round stock. Fig. 6—A fuller and the way in which it is used. Fig. 7—A half-round fuller and its uses. Fig. 8—A two-radius fuller. Fig. 9—Different ways of using a "set."

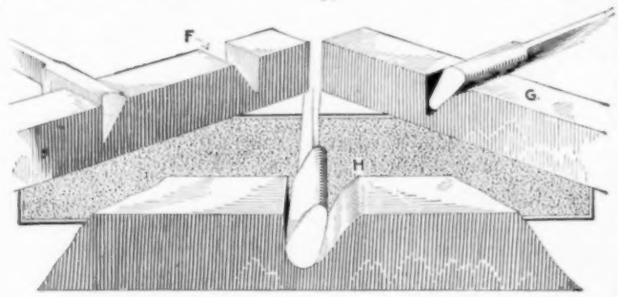


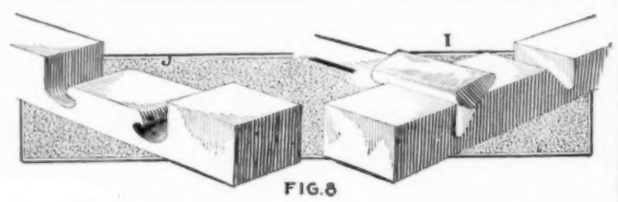


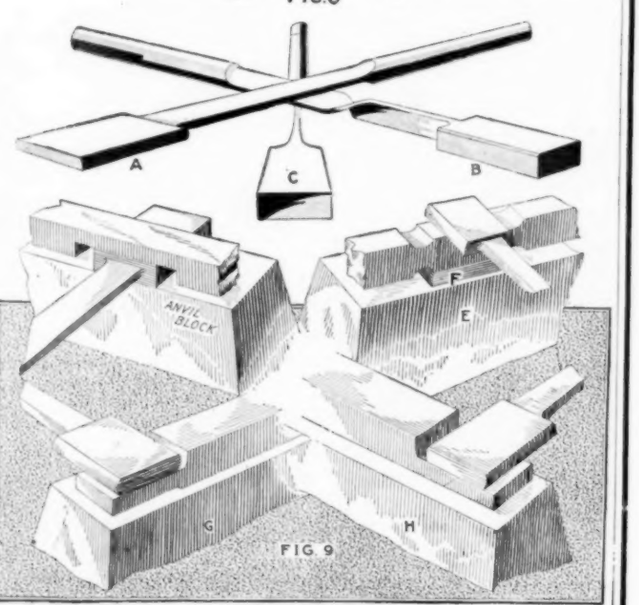












snap off the piece of stock with one blow, if possible. The foreman in charge of a shop using this method should never let his men do this operation without warning every man in the vicinity.

The fullers *A*, Fig. 6, should be made in an assortment of sizes. Their purpose is for necking a bar, as illustrated at *B* and *C*, where two different sizes of these fullers are shown. The smaller sizes should be made of material harder than the ordinary soft or mild steel, such a material as a low-grade tool or a tire or plow steel. At *D* is a double fuller bar, with a spring handle for necking both sides of a bar simultaneously.

The half-round fuller shown at *A*, Fig. 7, should be made in several sizes. Some of its uses are shown at *C*, *D* and *E*.

A special two-radius fuller is shown in Fig. 8 at *A*. It is used in connection with the necking tool *B* to form square shoulders. After a notch has been cut by the tool *B*, as at *F*, the tool *A* is used in the notch to open it up in the manner of *G*. The corner is thus

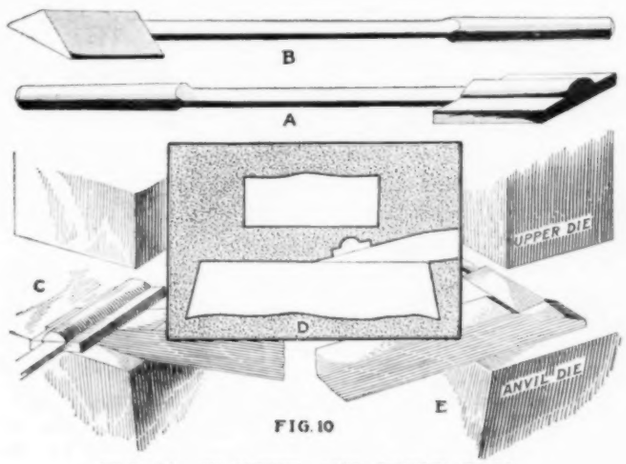


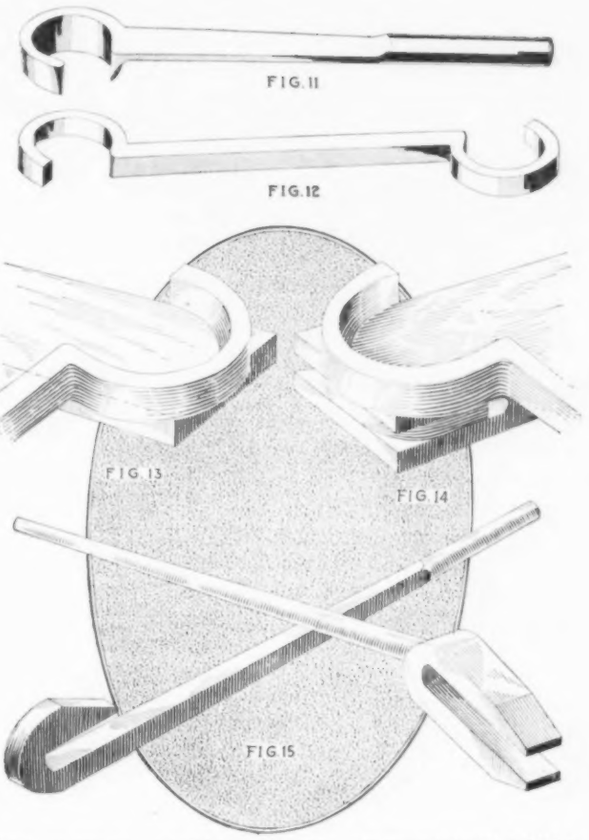
FIG. 10. FLATTER AND TAPER TOOL

worked out, sometimes using the large radius for the lower corners as at *H*. Another example is shown at *I* in drawing the stock between two shoulders; this space is too narrow to pass into the hammer dies without having them crush the shoulders. Should the corners not be worked in with a fuller, as indicated at *G* and *I*, these are apt to curl in during the drawing operation in the manner indicated at *J*, which will form a cold shut, where the edges curl in together.

The uses for the sets *A*, *B*, and *C*, Fig. 9, are numerous; and a well-equipped shop will have them in a number of sizes. The tool *A* can be used to work between shoulders of such cases as illustrated at *I*, Fig. 8. It can be used for making a short draw. When working between shoulders on the upper face of a forging, with shoulders on the lower face as well, as at *E*, it is good practice to lay a block *F* between the shoulders, as indicated. The set can then be used on the upper face without danger of distorting any of the shoulders.

The illustrations, *G* and *H*, also show the consecutive operation using a round-edge set to throw a shoulder to one side.

Other standard types of tools are the flatter and taper tools shown at *A* and *B* in Fig. 10. Some of the important places where these tools are of service are in dressing, smoothing and straightening tapered forgings, for throwing a taper to one side of a piece, or occasionally holding a tapered piece under the hammer.



FIGS. 11 TO 15. VARIOUS FORMS OF TRIMMING TOOLS

The method of employing these latter tools is as shown at *C*, *D* and *E*. The flatter *A* is harder to make and not so serviceable as the flatter *B*.

Special or Shaping Hammer Cutters

Under the heading of special or shaping cutters are those of the type shown in Figs. 11 and 12. These are usually made up for the job, unless there should be a standard piece of work made.

A set of the kind shown in Fig. 12 should be provided varying in size by half inches up to 6 in. in diameter.

If the cutter shown in Fig. 13 is placed flat on the material, two light blows of the hammer on opposite sides of the stock will do a neat job. These trimmers are usually made of small square or flat tool steel. A piece of tool steel $\frac{3}{8}$ x 1 in. will be large enough to

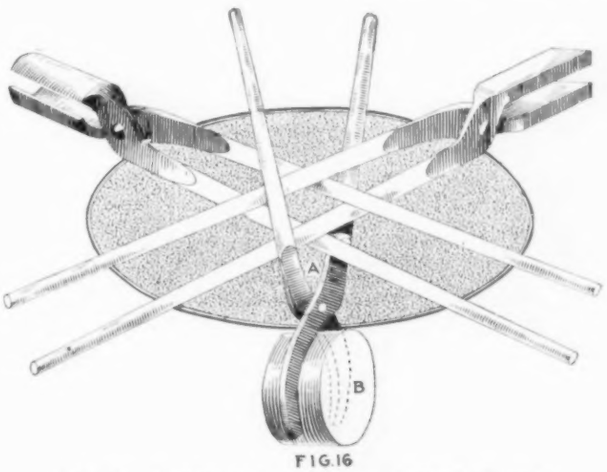


FIG. 16. KINDS OF TONGS IN GENERAL USE

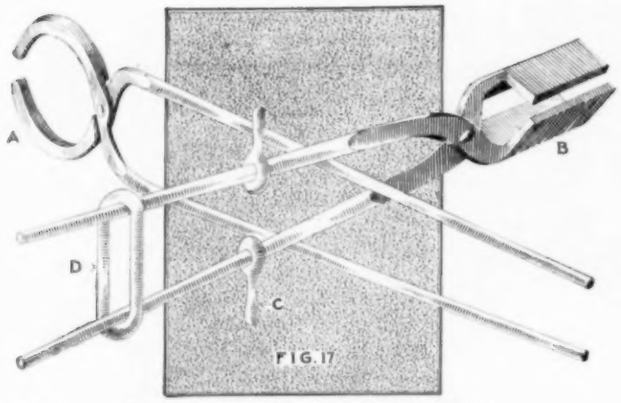


FIG. 17. OTHER KINDS OF TONGS

make a cutter for trimming 1½-in. stock if care is used in handling it.

Jaw forgings or similar work to that indicated in Fig. 14 can be trimmed off hot by placing a mandrel in the shell, which will act as the lower shear blade, the jaw being turned over to trim the other side. A block of a little greater height than the forging must be placed on the hammer die to protect it from the hammer.

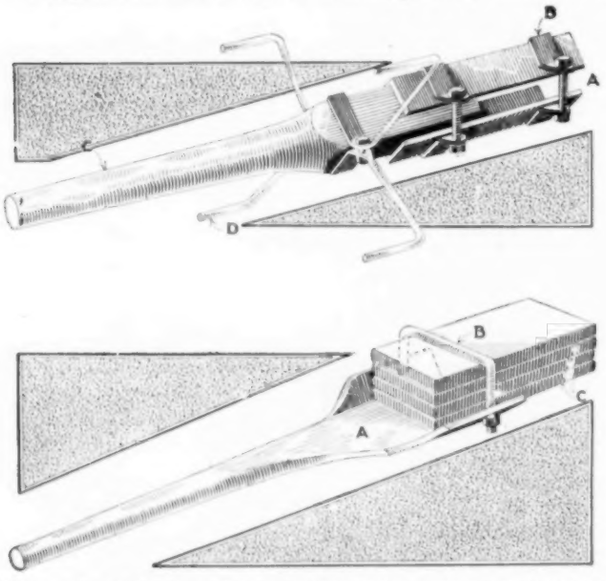
The twisters, or bending irons, shown in Fig. 15 are used for twisting or bending work when held under the hammer or for holding work under the hammer. Their size and shape depend entirely upon the size of forgings which are being handled.

Some Simple Forms of Tongs

In Fig. 16 are shown a few of the more simple forms of tongs, which in a general way follow the lines used for hand forge work, the only difference noticeable for hammer work is that they are made in larger and heavier sizes with longer handles, so that the man can handle the work more conveniently under the hammer. The tongs with the peculiar shape jaw as illustrated at *A* are for working disks *B* under the hammer.

The tongs *A*, Fig. 17, are used for working the edges of the disk. The points grip the disk near the center so it can be rolled back and forth under the hammer.

Tongs like *B* are used for handling heavy work. The handles *C* are for turning the work under the hammer. The slip ring *D* holds the tongs closed.



FIGS. 18 AND 19. TOOLS USED FOR HOLDING PIECES WHEN WELDING, OR "BUILDING UP"

A heavier form of tongs or clamp used for exceptionally heavy shafting and axle work is that shown at *A*, Fig. 18. It is made up of two angle irons, two clamps *B* and a wooden handle *C*. The levers *D* are clamped to the handle.

The hammer tool shown in Fig. 19 is used for piling up iron slabs *C* when welding to make large iron shafts or axles. These are laid on the flat end *A* and clamped by the U-bolt *B*.

Helping the Workman with His Financial Troubles

By Peter F. O'Shea

"I make it a practice to help men out of their financial troubles," says a manager of a shop employing 150 skilled workers. "A man who has financial trouble at home isn't of much use in the shop; his mind is elsewhere all day long.

"Any man in the shop may walk in and see me at any time. He and I sit down together and talk over his troubles. If I call him in on shop business, after we have disposed of that a word or two will elicit any personal problems he may have.

"After all, when a workman gets into financial troubles it is, as often as not, because he has no financial experience. Once in, for the same reason, he finds it doubly difficult to get out. He has only one family and one small home—too small a business, so to speak, to furnish a precedent in its own experience—and every move he makes is a crucial adventure.

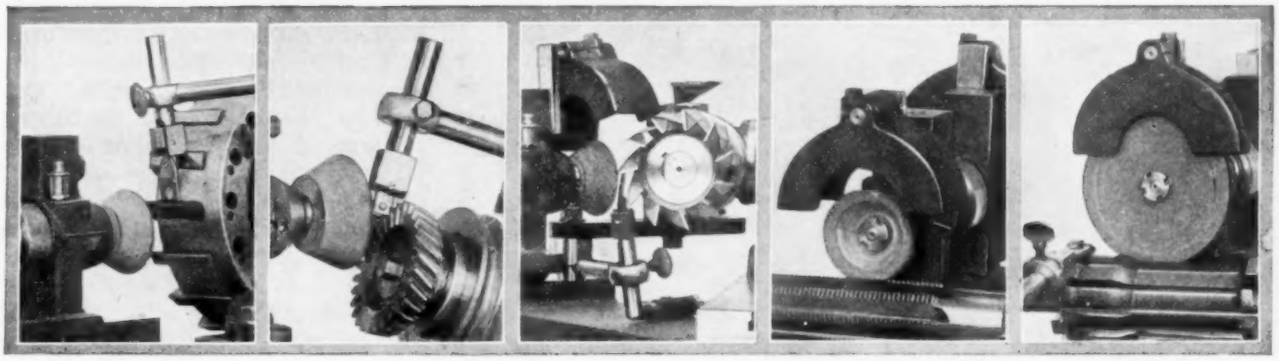
The Manager and Financial Problems

On the other hand, the manager has financial problems coming through his office daily just as pieces of product go through the man's machine. Just as the workman might be able to show the manager the proper and workmanlike way to do an operation on his machine, so the manager may be able to show the man how to let go of the tail of the financial bull and come around where he can get hold of it by the horns.

"I recently assisted one of my men to borrow about $200 to keep his feet from slipping while he was changing holds to the horns of his particular financial bull. Now he goes at his work bright-eyed and whistling. He has a cheerful grin. He is a different man. He is worth four of the man he used to be. Of course, he is paying back the loan out of his pay, but the company would have been a gainer even if it had given him the $200 outright.

"This is not paternalism. All the man needed was to be coached a little. After he has recovered from his difficulties, he has learned something. Later, in all probability he will want to consult you again, not about a defensive device, but a constructive one; such, for instance, as building a house. You are not putting your money at his disposal, but your financial experience.

"After men once see the effect of a little definite management applied to their personal problems, they inevitably become interested in turn in the shop's management problems. Their interest is not slavish, but receptive, intelligent, and even alert. The next time I want an improved method in the shop, I get coöperation. Yes, sir—coöperation in capittal letters."



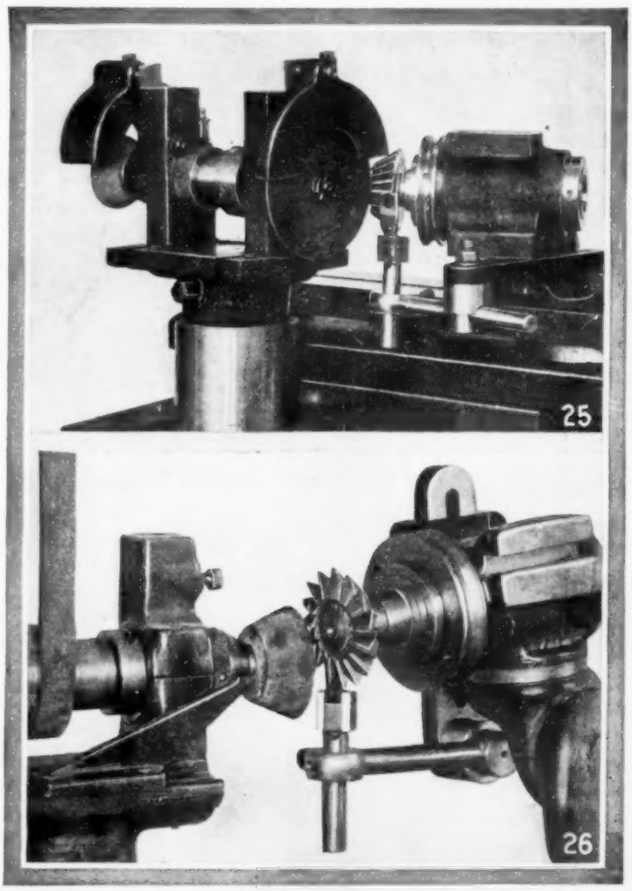
Latest Practice in Cutter Grinding*—III

Angular cutter grinding and the grinding of formed cutters are taken up in this installment of the cutter-grinding series which describes as well the grinding of taps. Methods of sharpening Fellows spur and spiral gear-shaping cutters and of sharpening and notching flat drill blades and some similar operations are also described.

FOR the purpose of analyzing the process of grinding, an angular cutter should be considered as made up of a number of plain milling cutters of different diameters.

When grinding any cutter with a cup wheel and following the usual method of obtaining the clearance by means of the vertical adjustment, the clearance angle is determined from the diameter of the cutter. It follows that this method will lead to difficulties when applied to an angular cutter because of the difference in the diameter of the cutter at different points along the cutting edge.

For this reason we have recommended the use of the disk wheel for angular cutters. When using a disk wheel the method of setting for clearance by means of the vertical adjustment of the knee does not lead to this difficulty, because now the varying factor is the diameter of the grinding wheel and not the diameter of the cutter. Fig. 25 shows the Cincinnati No. 1½ universal tool grinding machine set up for sharpening in this manner. Grinding wheel shape No. 5 is used.



FIGS. 25 AND 26. GRINDING AN ANGULAR CUTTER, AND A NEW METHOD FOR GRINDING ANGULAR CUTTER WITH A CUP WHEEL

The cutter is held on the end of the work-head spindle and secured by a split bushing or bolt through the spindle. The head is then swiveled to the angle of the cutter. The setting for clearance is as follows: The knee is raised to the zero line on the column, and the face of a tooth of the cutter is brought against the centering gage after which the spindle is locked. The tooth rest is placed on the swivel head and the blade against the tooth to be ground. The knee is then lowered sufficiently to give the clearance desired. The cutter is held against the tooth rest by hand and the lever feed is used in grinding. Left-hand cutters are ground in the same manner, except that the swivel head is set to the proper angle on the other side of the zero mark. By this method the operator must consult tables to learn the amount of adjustment required for a given clearance and further, in most cases, the disk wheel must be quite small in diameter to clear the tooth next to the one to be ground, at the small end of the cutter.

A very simple and correct method of sharpening angular cutters with either cup wheel shape No. 2 or disk wheel shape No. 5, is shown in Fig. 26.

The cutter is held in the work-head spindle in the regular way. The table is set at 90 deg. and the center of the work head brought in line with the grinding-wheel spindle by lining up one tooth of the cutter with the centering gage. Next, the work spindle is swung toward the grinding wheel through an angle, which is half the included angle of the cutter to be ground, bringing the tooth face parallel to the cup

*Copyright, 1919, by Cincinnati Milling Machine Co. From a forthcoming treatise on Cutter Grinding.

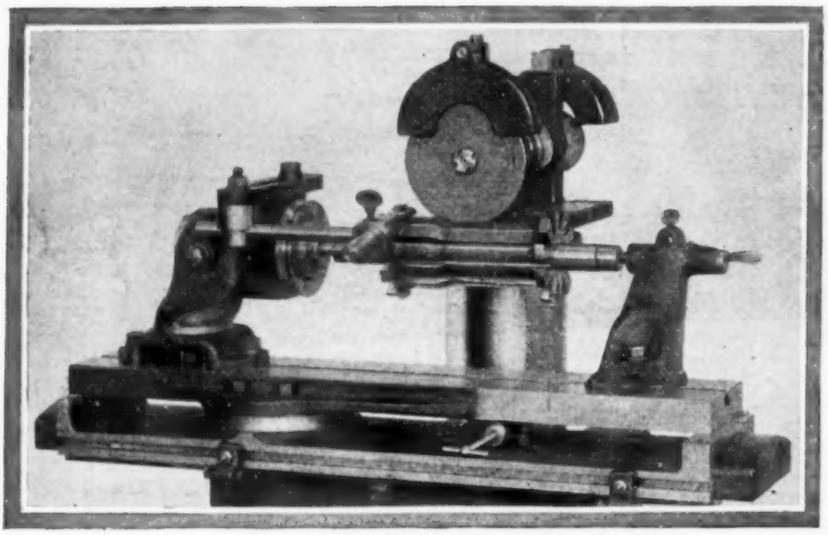


FIG. 27. SHARPENING A FORMED CUTTER

sharpened by grinding the faces of the teeth and they retain their original outline only when the teeth are ground radially and straight. This type of cutter is given its cutting clearance by the relieving or backing-off operation, which is part of the process of making the cutter. This must never be disturbed, and, therefore, such a cutter must positively not be ground on its periphery.

To set up for grinding a formed cutter, the centers are brought in line with the face of the grinding wheel. The cutter, mounted on a mandrel, is placed in position and the face of a cutter tooth brought against the face of the grinding wheel, Fig. 27. The tooth rest is then set against the heel of the tooth, as shown. To adjust the work to the wheel while grinding the cutter is revolved toward the wheel a slight amount by tapping lightly against the tooth-rest holder. This keeps the faces of the teeth radial and maintains the correct cutter profile. Grinding wheel shape No. 3 is used. A tap is made almost like a formed cutter and the method of sharpening is similar. The faces of the teeth must be ground radially and straight. Either grinding wheel shape No. 2 or No. 3 is used. The work is held between centers as shown in Fig. 28. The tooth rest is mounted on the work head with the blade resting against the face of the groove, which is milled into the tap for the chip clearance. When this is not possible, the tooth-rest blade should rest against the heel of the threads as shown in Fig. 27 for formed cutters. To adjust the work to the wheel while grinding, the tap is slightly rotated toward the wheel by tapping against the tooth rest.

wheel. The setting gage is placed under a tooth of the cutter, the tooth rest mounted on the work head and the blade set under the tooth after which the work spindle is locked. The work head is depressed by the number of degrees desired for the clearance angle. When using a cup wheel, the knee is raised or lowered so that wheel will clear the next tooth. If the disk wheel is used, the knee is raised so that the tooth is again on the level with the setting gage before proceeding to grind the cutter. In the case of a double-angle cutter which has two angular edges to be ground, it is not always necessary to reset the tooth rest; it is only necessary to swing the work around to bring the other angle of the cutter in position. Thus the entire grinding operation is accomplished without the necessity for more than one setting of the work.

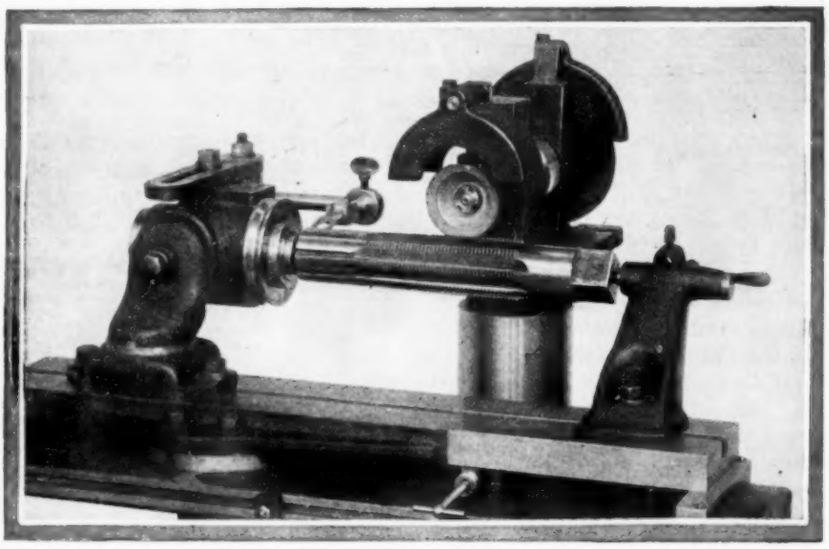


FIG. 28. SHARPENING A TAP

Form relieved cutters are used for finishing machine parts to an exact outline. These cutters are

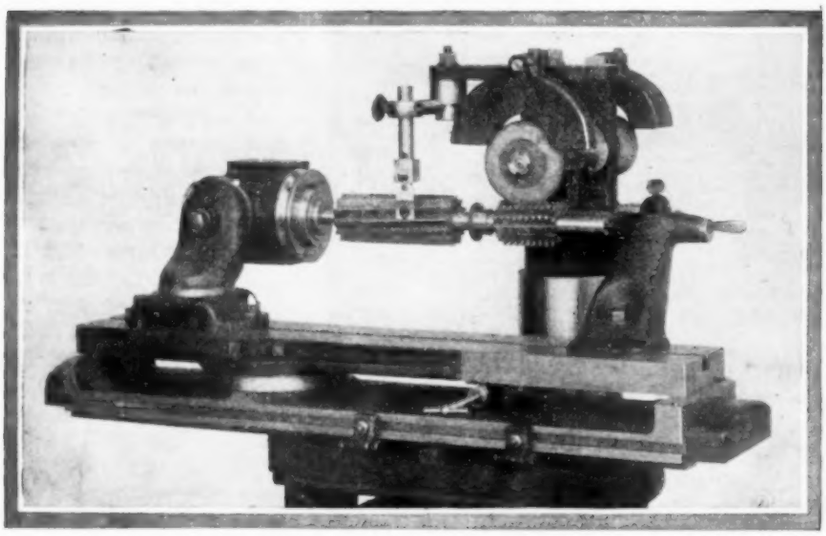


FIG. 29. USE OF A MASTER FORM IN GRINDING SPIRAL HOBS

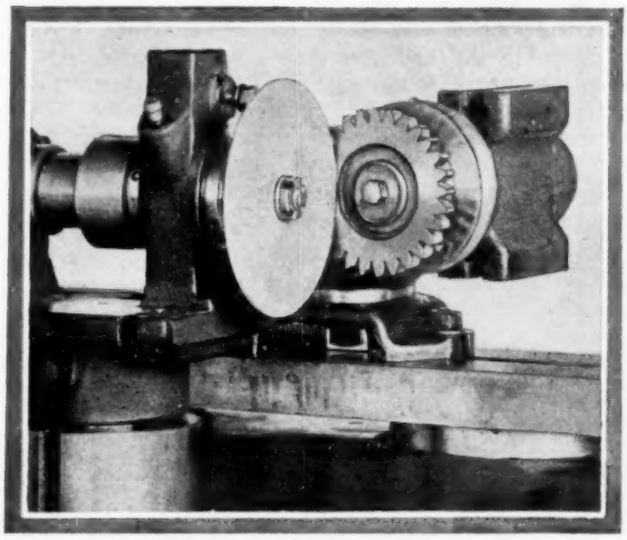


FIG. 31. SHARPENING A FELLOWS SPUR-GEAR CUTTER

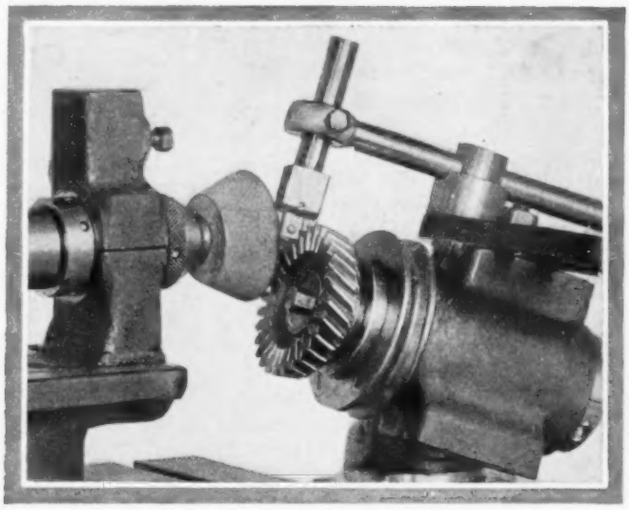


FIG. 32. SHARPENING A FELLOWS SPIRAL-GEAR CUTTER

Hobs with straight teeth are ground in the same way as formed cutters, as illustrated in Fig. 27. Attention is again drawn to the fact that after each grinding the hob should be revolved toward the wheel for taking additional cuts and not adjusted by means of the cross screw, because the latter would produce a tooth face which would not be radial, and this would, of course, change the profile of the teeth.

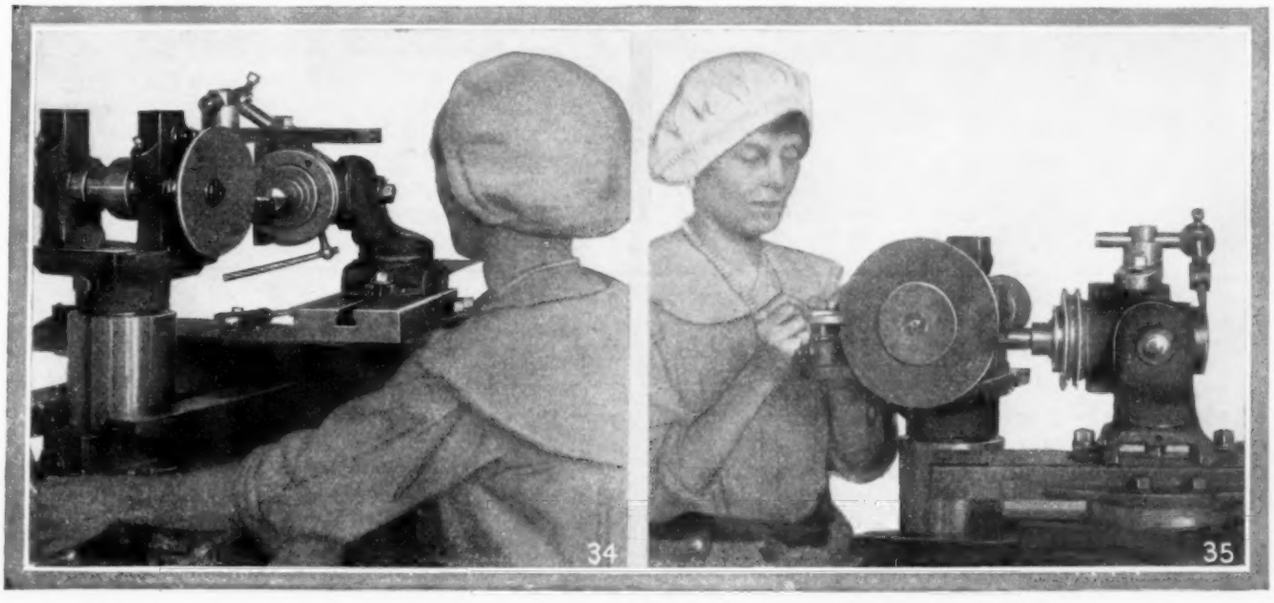
For hobs with spiral teeth, the use of a master form is recommended as a guide for the tooth rest, as illustrated in Fig. 29. This master form "B" is milled with the same spiral as the hob and its accuracy determines the accuracy of the hob after grinding The wheel (shape No. 5) should be dressed to a sharp edge and to the same angle as the cutter that milled the hob. The hob is adjusted vertically to the grinding wheel for the required depth and by using the cross adjustment the grinding wheel is brought in perfect alignment with the gage *A*, Fig. 30. This assures perfect radial alignment of the hob and wheel. No further cross adjustment need then be made during the whole grinding operation. The wheel is brought against a tooth of the hob, the tooth rest is set against the tooth of the master form and we are ready to grind.

To adjust the work to the wheel while grinding, the hob must be revolved toward the grinding wheel a slight amount in order that the faces of the teeth may be kept radial. This is done by revolving the master form on the mandrel in the opposite direction the desired amount. Setscrews which hold the master form to the mandrel facilitate this adjustment.

Grinding Fellows Gear Cutter

Sharpening a Fellows spur-gear cutter is a plain disk-grinding operation. The cutter is held on a stud mounted in the work head which is set to an angle of 5 deg., representing the rake of the cutter. Grinding wheel No. 17 is recommended.

Grinding a Fellows helical-gear-shaping cutter is accomplished in a very simple manner, as shown in Fig.



FIGS. 34 AND 35. SHARPENING A FLAT-DRILL BLADE AND GRINDING CHIP BREAKER GROOVES IN A FLAT-DRILL BLADE

32. The cutter is mounted on a stud, which fits the taper of the work-head spindle. Two angles must be maintained, (a) the angle producing the rake of the cutter, and (b) the helical angle. The horizontal swivel provides for obtaining the top rake of the cutter by adjusting the head 5 deg. from parallel with the wheel spindle so that the tooth will be ground at an angle of 5 deg. toward the center. For the proper helix angle, the work-head spindle is swung by means of the vertical swivel to the same angle as the helical angle of the cutter. For a right-hand cutter the spindle is swung up as shown; for left hand, down. The tooth rest is held on the work hand, standard grinding wheel No. 2 is used, and the process of grinding is the same as for the face teeth of a shell end mill.

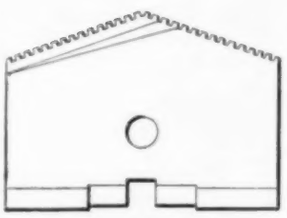


FIG. 33. A FLAT-DRILL BLADE

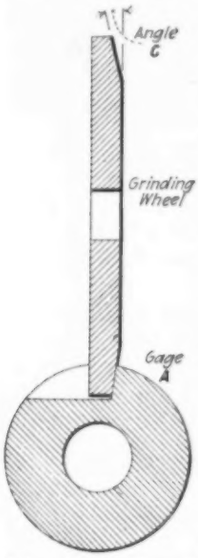


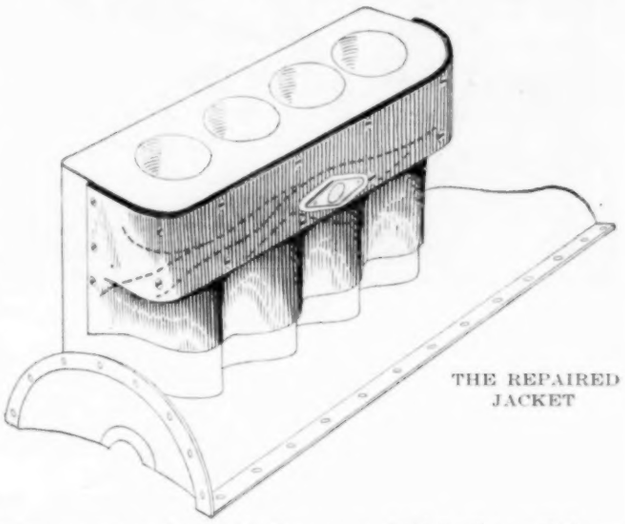
FIG. 30. THE USE OF A SETTING GAGE FOR SPIRAL-HOB GRINDING

The flat-drill blades, shown in Fig. 33, are used for boring deep holes, and to a very large extent on automatic screw machines. When grinding, the blades are held on an arbor fitted in the spindle of the work head of the grinding machine. Clearance is obtained by lowering the knee. Fig. 34 shows the operation, grinding wheel No. 17 being used..

Fig. 34 illustrates grinding the chip breakers in the face of these flat-drill blades. For this operation the work rest is used in combination with a special grinding wheel No. 7.

the water jacket, and because of the proximity of some of them to the cylinders, there was a possibility of warping the bore and making necessary considerable extra work to finish the cylinders so that they could be used; so we decided to put a patch on the outside.

The patch was made of $\frac{1}{8}$-in. sheet steel. The sketch shows how it was bent up and shaped to fit the cylinder. The sheets were clamped in position and wherever it



THE REPAIRED JACKET

was necessary to bend, draw, or stretch the metal we heated it with a welding torch, using sets and calking tools to shape it.

The sheets were formed in two separate pieces and after they were fitted we drilled and tapped $\frac{1}{4}$-in. stud holes to fasten them down in various places, later welding the two pieces together to form a one-piece patch.

After the drilling was completed, we cleaned the surfaces of dirt and placed a sheet of $\frac{1}{8}$-in. uncured vulcanizing rubber over the surface that was to be covered by the patch, placed the patch on and carefully drew up on the studs which held it to the cylinder.

The cylinder head and all openings were then closed with the exception of one for an inlet and another for a drip, and steam pressure was gradually applied to warm up the block, the drip being left open to take care of the condensation so as to get a uniform heat throughout. After the metal started to warm up we gradually drew up on the bolts, increasing the steam pressure until the desired heat was obtained, when the pressure was held at this point until the rubber filler was vulcanized. The cylinder has been in service a number of years and has given entire satisfaction.

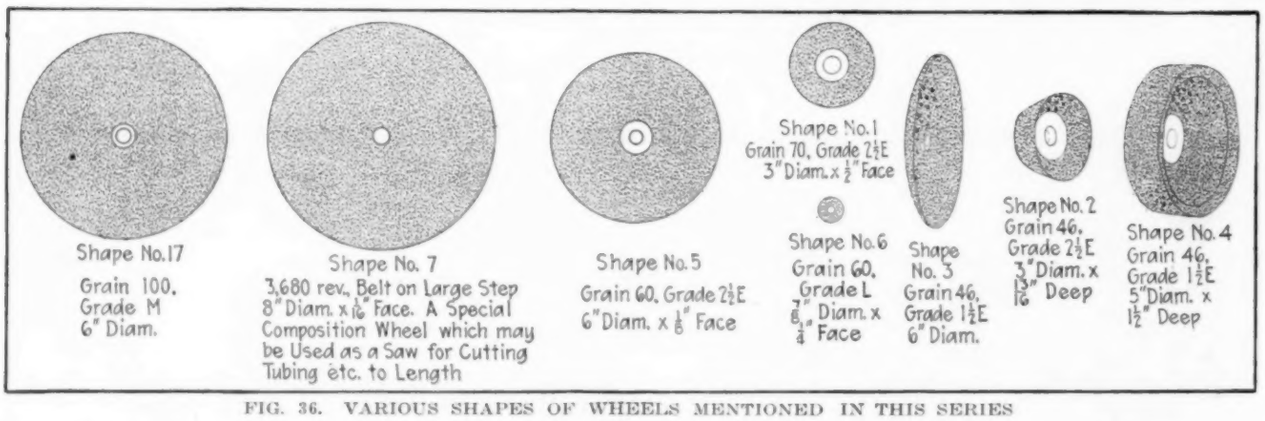

Shape No.17
Grain 100, Grade M
6" Diam.
Shape No. 7
3,680 rev., Belt on Large Step
8" Diam. x 1/16" Face. A Special Composition Wheel which may be Used as a Saw for Cutting Tubing etc. to Length
Shape No. 5
Grain 60, Grade 2½E
6" Diam. x 1/8" Face
Shape No. 1
Grain 70, Grade 2½E
3" Diam. x ½" Face
Shape No. 6
Grain 60, Grade L
1" Diam. x 1/4" Face
Shape No. 3
Grain 46, Grade 1½E
6" Diam.
Shape No. 2
Grain 46, Grade 2½E
3" Diam. x 13/16" Deep
Shape No. 4
Grain 46, Grade 1½E
5" Diam. x 1½" Deep

FIG. 36. VARIOUS SHAPES OF WHEELS MENTIONED IN THIS SERIES

Repairing a Cracked Cylinder Jacket

BY A. H. YOCK

Some time ago I was quite successful in repairing a badly cracked water jacket on an automobile motor and the manner in which the work was done may be of interest to someone else in the same predicament.

The motor was of an obsolete type and it was therefore impossible to secure a duplicate cylinder block and the owner desired to have it repaired if possible.

While it may have been practicable to weld, that method had been tried without success. The casting had a number of cracks running in all directions along

The Williams Internal Gear

BY REGINALD TRAUTSCHOLD

The cycloidal gear tooth has yielded to the involute and the involute has been succeeded by the stub tooth for certain types of work. The latest system of gear-tooth design, here described, bids fair to drive the other types from its special field, that of internal gearing, for the practical reason that it is easier, quicker and cheaper to make.

DEVELOPMENT along one line of mechanical endeavor invariably entails the further refinement and utilization of another already known and familiar mechanical principle, and occasionally the improvement in the known mechanism is radical and far reaching. The improvement may be coincident with the development or it may have preceded it and been an independent evolution, but the improvement occurs.

The development in motor truck, tractor and heavy-duty vehicle driving mechanisms has brought about a heretofore unknown demand for accurately proportioned internal gears for the final speed reduction of the transmission. Such a construction eliminates the noisy and bothersome chains so generally used in the past for motor-truck drives and the fact that the power is delivered to the driving wheels nearer their periphery makes the transference of power more economical than in the case of worm-drive transmissions. These distinctive advantages are so evident that they need no elucidation. Rather, their tardy recognition seems strange.

Advantages of Internal Gearing

Internal gearing permits a compactness of design impossible with externally meshing gears; the internal gear forms its own gear guard—a safety feature that must eventually create an important use of internal gears in machine-tool drives, etc.; tooth contact is over a considerably longer arc than in either external or rack gearing; there is a reduced sliding action between meshing teeth; internal gear combinations are quieter in action and so operate more smoothly than do external gears; wear is reduced and the gears have a considerably longer life of usefulness.

With such a formidable list of advantages favoring the internal gear, its chief limitation in the past has been the difficulty and cost of accurately cutting the internal-gear teeth. Fortunately, this drawback has now been in large measure overcome by the development of the generating machines of approved type for cutting gear teeth—notably, the Fellows gear-shaping machine. In fact, it has been the development of this efficient tool that has made possible the fact that a very large proportion of the modern auto trucks and tractors are now equipped with internal gears for the final speed reduction of their transmissions.

Refinement and utilization of a known mechanical principle due to the development along a line of mechanical endeavor is apparent, but in the generation of gear teeth no radical improvement can be claimed. The teeth are generated according to the well-known involute system of gearing, the limitations of which are considerably more marked in internal gears than they are in externally meshing gears or in gear combinations where one of the members is the involute rack that governs the form of involute teeth.

The involute system of gearing is based on the hypothesis that if gears will mesh with a standard involute rack they will mesh one with the other. In other words, as every involute gear will mesh with an involute rack the assumption is that every involute gear will likewise mesh with every other involute gear of the same pitch and pressure angle, and an interchangeable system of gearing will be thus secured. Due to the interference of gear teeth, however, the profiles of "standard" involute teeth have to diverge considerably from the true involute curve for the greater part of their depth. This is true in the case of external gearing and to a much more marked extent in internal gearing. The necessary modification of the tooth profile causes the "standard" involute gear tooth to lose to a large extent the advantages the involute system is supposed to possess—that of interchangeability.

Limitations of Involute Gears

This drawback of the involute system places a practical limit to the minimum number of teeth an involute gear may have—generally taken as 12—so that in order to secure necessary speed ratios with a tooth of adequate strength, while retaining the "standard" involute tooth profile, an increase in the pressure angle and the stub form of tooth is frequently resorted to. In this manner, a gear combination is secured with a longer arc of contact, but with a sacrifice in the power-transmission efficiency of the gearing. The flat pressure plane of the involute system passing through the instantaneous axis of a pair of meshing gears, the greater the pressure angle the greater also the axial, or radial, component of the power transmitted and the smaller the effective component.

The Williams' System of Internal Gearing

In the Williams' system of internal gearing the forms of the teeth in both the internal gear and the mating pinion depart radically from those proportioned according to other gearing systems, and in so doing secure certain inherent advantages that give to the gearing an improved operating action, reduce wear and increase the strength of the pinion teeth. The limitations placed on internal gearing by the involute system are materially reduced, while all the advantages of internal gearing are retained and accentuated. Furthermore, the cost of cutting Williams' gears is very much less than that of gears of any other form.

The teeth of the internal gear are made with straight-line profiles—the bounding profiles of the tooth spaces being similar to those of an involute rack—while the teeth of the mating pinion have curved profiles of conjugate form. Dispensing with the questionable advantage of interchangeability, claimed for the involute system, removes the necessity of modifying the form of the internal gear teeth—the profiles of the teeth always being flat surfaces inclined at a fixed angle to the center line of the tooth space—for in all cases

the teeth of the mating pinion are of conjugate form. Interference is practically eliminated, for pinions with only a few teeth—three or four, if advisable—may be employed with the assurance that if they can be cut they will also operate without interference. This simple combination causes the point of contact between gear and pinion teeth to follow a distinctive path throughout their arc of contact—see **Fig. 1.**

As illustrated, with the gears in full mesh on the instantaneous axis, it is evident that the flat profile planes of the internal-gear teeth are all tangent to a circle, concentric with the internal gear, having a radius equal to the pitch radius of the internal gear multiplied by the sine of the instantaneous pressure angle or the sum of one-half the tooth space angle and one-quarter the pitch angle of the gear. The path

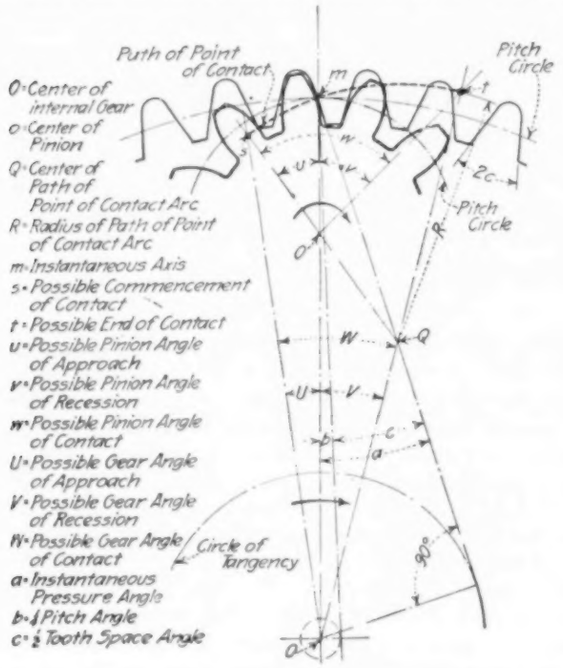

Path of Point of Contact
Pitch Circle
O=Center of internal Gear
o=Center of Pinion
Q=Center of Path of Point of Contact Arc
R=Radius of Path of Point of Contact Arc
m=Instantaneous Axis
s=Possible Commencement of Contact
t=Possible End of Contact
u=Possible Pinion Angle of Approach
v=Possible Pinion Angle of Recession
m=Possible Pinion Angle of Contact
U=Possible Gear Angle of Approach
V=Possible Gear Angle of Recession
W=Possible Gear Angle of Contact
a=Instantaneous Pressure Angle
b=¼ Pitch Angle
c=½ Tooth Space Angle
Circle of Tangency
2c
90°

FIG. 1. LAYOUT OF WILLIAMS' INTERNAL GEAR AND PINION

of the point of contact, *smt*, being at all times normal to the working profiles of the active internal-gear teeth, as they pass the instantaneous axis, will follow the curved path traced by the apex of a right-angle triangle having for a base a radiant of the circle of profile plane tangency and a hypothenuse connecting the path of point of contact with the center of the internal gear. Between the limiting points, *s* and *t*, on such path at which contact between mating teeth can occur—the usable section of the path—the curve, to all practical intents and purposes is the arc of a circle passing normally through the instantaneous axis and having for its center the mid-point of the line connecting the instantaneous axis with the foot of the normal radius of the circle of profile plane tangency. The extreme ends of the usable path of point of contact are set by radii of the describing circle passing respectively through the center of the pinion and that which if prolonged would pass through the center of the internal gear.

The radii connecting the ends of the usable path of point of contact with the centers of the gears will subtend on the respective pitch circles of the gears their maximum arcs of contact and, though it is quite apparent that the length of the arc of contact is unusually great in the Williams' construction, the superiority of the Williams' system in this important respect is perhaps more clearly demonstrated by a comparison with the length of the arc of contact for similar gears proportioned according to the involute system. Such a demonstration will also illustrate the reason for the common practice of increasing the pressure angle of involute gears and adopting the stub form of tooth.

The two sets of arcs in contact, shown in Fig. 2 diagrammatically, depict sections of pitch circles of equivalent internal gearing of the involute and Williams' form respectively. The shaded areas between the pitch circles of the gears and pinions—*X* and *Y* respectively—indicate areas in which no part of the path of point of contact can lie, since interference between the gear and pinion teeth would result.

Diagram I indicates a set of involute gears in which the path of point of contact is straight and passes through the instantaneous axis. The commencement of contact between meshing teeth of involute profile is fixed by the point of the path of point of contact which is normal to a radius of the pinion pitch circle and the angle of approach—the angle included between such normal pinion radius and the radius to the instantaneous axis—is equal to the pressure angle of the teeth. The angle of recession, the balance of the angle of contact, is limited by the outer diameter of the

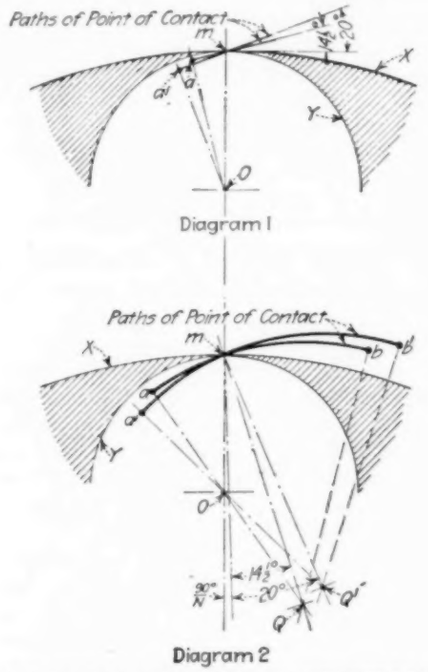


FIG. 2. COMPARISON OF INVOLUTE AND WILLIAMS' SYSTEM POINT-OF-CONTACT PATHS

pinion and is so regulated by the addendum of the pinion teeth. However, as the tops of the pinion teeth will be cut away if they are unduly long, the arc of contact for involute internal gears is of necessity relatively short, even though a heavy pressure angle be employed and the stub form of tooth adopted.

The second diagram, Fig. 2, portrays an equivalent Williams' gear combination, with paths of point of contact shown for both 14½- and 20-deg. teeth. It will at once be noted that the possible angle of approach for the 14½-deg. tooth is decidedly larger than the angle of

approach for even a 20-deg. involute tooth, and though the possible angle of recession for the Williams' gears is finite, instead of being theoretically infinite, as in the case of the involute system, it is considerably larger than the practical recession angle for either 14½- or 20-deg. involute systems. In fact, the length of the arc of contact for the 14½-deg. teeth of the Williams' form would be nearly 25 per cent. greater than that for 20-deg. involute teeth of the same proportions and most practical depth, even though, for Williams' teeth of the same depth, only a small portion of the usable path of contact would be utilized.

Wear

The longer arc contact in the Williams' system of internal gearing means a correspondingly longer period during which engaging teeth are in contact and, therefore, a better distribution of the load, with the wear correspondingly reduced. Then, as the angle of approach is not controlled by the pressure angle so much as it is by the inner diameter of the internal gear, it is practicable to use a lesser pressure angle and employ teeth of standard depth, thereby presenting a better profile area over which to distribute the wear.

Another peculiarity of the Williams' construction which improves the action of the teeth is that such concentration of wear as does take place is toward the roots of the pinion and gear teeth, where, so far as the strength of the teeth is concerned, wear can best be withstood, and with the result that the slight relief thus secured tends to ease off the shock of initial contact and so produce quieter and smoother operating gears.

The pinion in a gear combination where both gears are of the same material is invariably the weaker member and for this reason the strength of gearing has to be gaged by that of the pinion teeth. This is due to the fact that the pinion teeth are always more undercut than the gear teeth and also because the pinion teeth are subjected to the greater amount of wear, the individual pinion teeth being under load more frequently than the separate gear teeth. The relative weakness of pinion teeth is an inherent peculiarity of all toothed gearing, but in the case of the Williams' system of internal gearing the pinion is not proportionally so much weaker as in the involute system. The gear teeth in the Williams' system are not quite so strong as

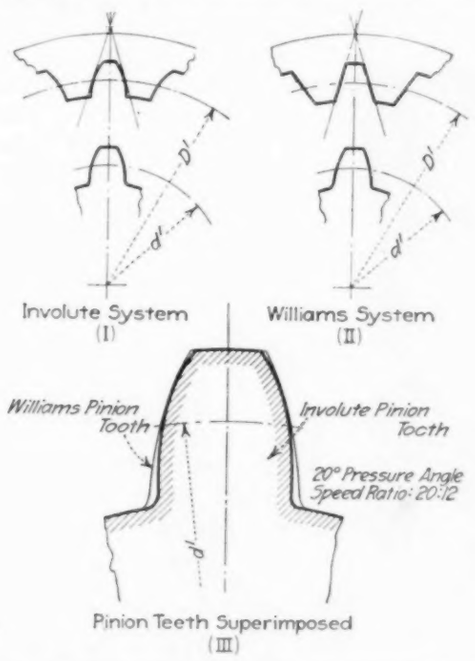


FIG. 3 COMPARISON OF FORMS OF PINION TEETH

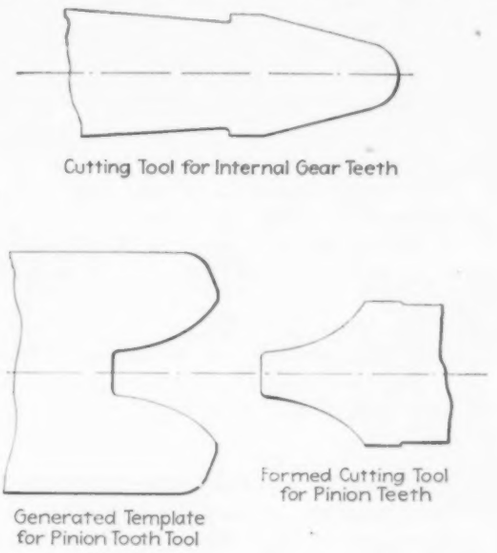


FIG. 4. FORMS OF CUTTING TOOLS FOR WILLIAMS' SYSTEM GEAR TEETH

those of equivalent involute internal gears of similar tooth depth and pressure angle, but the strength of the internal-gearing combination as controlled by the strength of the pinion teeth is considerably the greater in the Williams' system.

The curved profiles of an internal-gear tooth of the involute form are concave on either side of the pitch circle and curve away from the contact plane tangent to the tooth on the pitch line. The straight-line profiles of a Williams' internal-gear tooth, on the other hand, lie in the contact planes. The extra tooth thickness of the involute internal-gear tooth necessitates a proportional decrease in the top thickness of the mating-pinion tooth, which, though perhaps not weakening the pinion tooth, does limit the practical depth of the pinion tooth addendum and correspondingly the dedendum of the internal-gear tooth. The increased top thickness of the involute form of internal-gear tooth, however, does materially weaken the tooth of the mating pinion, on account of the greater amount of undercutting necessary for the teeth to clear.

The relative strength of Williams' and involute pinion teeth of the same depth is strikingly illustrated in the view of superimposed teeth, shown in Fig. 3, while the smaller diagrams in the same illustration depict the difference in the form of the internal-gear teeth and the effect of the variations upon the shape of the pinion teeth. The comparison is selected with a view of emphasizing the greater strength of the Williams' pinion tooth by an illustration that favors the involute system, rather than the Williams' construction. The speed ratio of the combinations shown, 20 to 12, is low, the teeth are of the 20-deg. type and the pinions have a sufficient number of teeth, so that the involute pinion is noticeably free from the weakening effect of undue undercutting. Despite this, the Williams' tooth is about 36 per cent. stronger than the pinion tooth of involute form—the strength of the respective pinion teeth varying as the square of their root thicknesses.

To enlarge upon the superiority of the Williams' system of internal gearing in respect to increased length of useful life, considering its improved operating action, increased resistance to wear, the greater strength of its pinion teeth and the fact that combinations with fewer and stronger teeth may be employed, would seem to be unnecessary, but a general estimate of the average life of the gearing compared to similar combinations proportioned according to the involute system may be of interest.

Assuming that the average speed ratio of internal-gear combinations is in the neighborhood of 4 to 1, the aggregate advantages of increased arc of contact, more effective tooth profile area over which contact takes place and the material superiority of the pinion-tooth form in respect to strength would measure in terms of respective durability of the combinations about two to one. Furthermore, this measure of superiority could be increased considerably by taking advantage of the fact that pinions with fewer and more rugged teeth can be employed in the Williams' system.

Machining Teeth

The straight-line profiles of the Williams' internal-gear teeth make their accurate cutting a comparatively simple and inexpensive operation. A plain V-shaped, reciprocating cutting tool, Fig. 4, will gash out the tooth spaces rapidly and finish the two bounding profiles of a tooth space at one setting of the gear blank in an ordinary shaper. To cut the next tooth space, the blank simply has to be indexed around the proper amount and made secure. If the internal gear is of the ring type, the tooth spaces can be milled with even greater rapidity, the cutter—as in the case of the simple reciprocating tool used for shaping—being easily ground with the utmost precision.

The machining of the pinion teeth calls for the use of a simple generating machine for cutting the teeth or for generating an accurate templet of the pinion-tooth space to which an accurately formed cutting tool for machining the pinion-tooth spaces is readily fitted. Fig. 4.

As the pinion of the ordinary internal-gear combination has comparatively few teeth, their generation is a simple task compared to that of generating the teeth of both the pinion and the mating gear, but when a large number of pinions of the same proportions is required, as in quantity production of any standardized product employing internal gears, a formed cutter, fitted to a generated pinion-tooth space templet, will hasten and cheapen the cost of machining the pinion teeth.

Cost of Machining Williams' Gears

The cost of cutting Williams' internal gears and gear combinations is quite obviously very much less than that of machining similar gears of other tooth form, and the manufacturing economy of the Williams' gears is more and more marked as the difference in the number of teeth in the internal gears and their mating pinions increases.

In connection with the cost of machining, some interesting estimates have been made as to the relative cost of machining simple internal-gear combinations proportioned according to the Williams' and the involute systems. The average speed ratio is taken as 4 to 1 and the relative time consumed in cutting a gear combination proportioned according to the Williams' system, compared to that required to generate similar gears proportioned according to the involute system is said to be: when generating all the Williams' pinion teeth, 50 to 60 per cent., and when machining the Williams' pinion teeth with a formed cutter, 30 to 40 per cent. In addition to this very material saving in the time required to machine the gear teeth, less skilled operators may be employed for the simple machining operations entailed in cutting Williams' gears than can be entrusted to operate the more intricate machine tools required for generating the involute form of tooth, so that the cost of manufacturing Williams' internal gears and their mating pinions is unquestionably very much less than that of generating similar gears of the involute type.

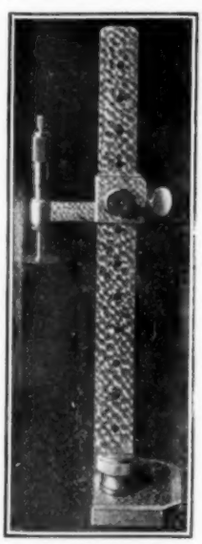
Conclusion

The important advantages of economy and simplicity in manufacture are so distinctly possessed by the Williams' system of internal gearing that this improvement of a familiar mechanism—which was to be anticipated when the large demand for internal gears was created—promises to be a valuable factor in many of the improved forms of mechanisms for mechanical transmission of power. The Williams' system may not have been devised before the more obvious of the present markets for internal gears was developed, but its commercial introduction comes at an exceedingly opportune time.

Micrometer Height Gage

By H. Kiehne

The vernier height gage fitted with a scriber is commonly used by toolmakers for laying out master plates or similar work, for which purpose its utility is beyond question, but in the matter of accurate setting there is an opportunity for mistakes due to the personal equation, that do not exist in, or are at least very much reduced by, the micrometer.



A MICROMETER HEIGHT GAGE

For that reason I made the tool shown in the cut herewith solely for the purpose of scribing lines accurately spaced distances apart.

The construction should be obvious at a glance. The micrometer head is the regular commercial tool sold by most makers of micrometers, and the scriber is a disk ground to a sharp V-edge and notched something like a circular saw except that no rake is required on the "teeth," or any clearance, as the teeth are brought to sharp points.

The advantage of the tool lies in the facility with which it may be set. The holes in the bar are one inch apart, the fractions being obtained by the micrometer. The numerous scribing points presented by the disk enable the tool to be presented to the work at any angle. The spindle lock prevents the disk from turning and thus altering the setting while being used.

Careful work is necessary in making the disk and attaching it to the spindle, for if it was not "dead true" there would be variations in the height of resulting lines from presenting the scriber to the work at different angles.

Automotive Construction

The Hispano-Suiza Airplane Engine—III

By H. O. C. ISENBERG
Works Manager Wright-Martin Aircraft Corporation, New Brunswick Plant

The pattern equipment of this concern represents an investment of approximately half a million dollars. A similar amount was expended for the equipment of their foundry and the product is a very high grade of aluminum castings.

OWING to the extreme accuracy of the patterns made in the Wright-Martin shop and to their interchangeability the work of molding the cylinder blocks has been reduced to a system in which the molds for the various parts, drags, cheeks and copes, are made in quantities by gangs of men, and from these stocks of mold parts the mold assemblers build the complete molds.

In Fig. 30 is shown a cylinder-block casting just as it goes to the cleaning room. These castings, exclusive of the gates and risers, weigh 55 lb. with a tolerance of plus or minus half a pound. One of the secrets of successful aluminum casting is the use of liberal gates and risers. Taking all the aluminum work produced by our foundry the gates and risers will amount to about 45 per cent. of the weight of the casting as it comes from the sand. On ordinary commercial work which is much heavier than ours, such heavy gates and risers are of course not necessary.

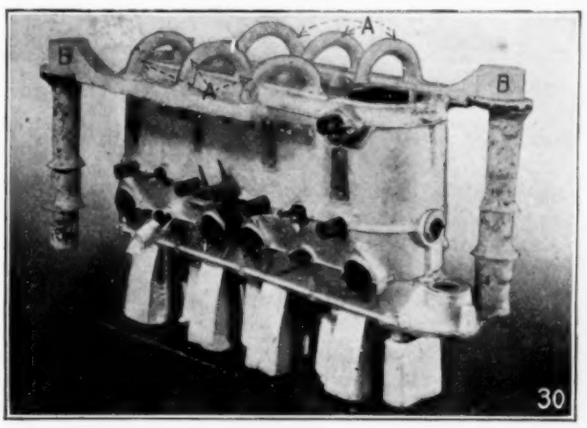
In the cylinder-block casting the walls around the cylinder are $\frac{3}{4}^{1}$ in. thick and a variation of $\frac{1}{16}$ in. from standard in any part of this casting means rejection. As the total rejections for all causes are less than 7 per cent. those for variations in wall thickness are very few.

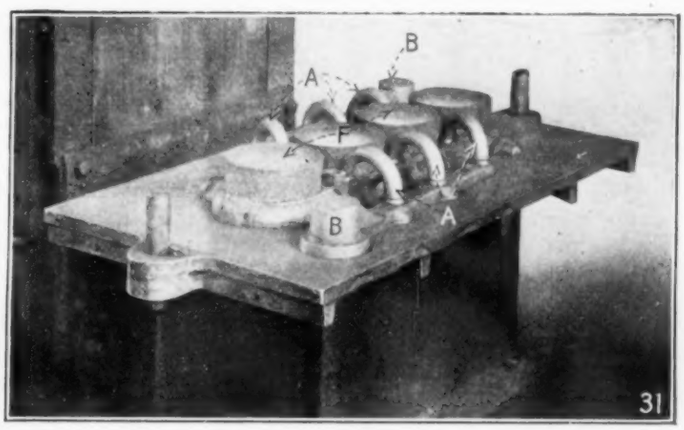
We will follow the molding of the various parts of the mold in the order in which they are assembled, starting with the drag.

In Fig. 31 is shown the drag pattern in place on the roll-over machine. The horn gates *A* are of great advantage in this work and since their adoption losses have been sufficiently reduced to more than warrant their use. The print *B* at the bottom of the pouring gate is for the strainer core which will be shown later in connection with the assembling. The center line of the horn gates is a true segment of a circle and the gates themselves are tapered. In other words they are cones bent to a circle so that they can readily be removed from the mold. They are held in place during the ramming of the mold by dowels at each end. After the mold is rammed and struck off, the board *C*, Fig. 32, is clamped in place and the mold rolled over. The pattern is then drawn leaving the loose horn gates in place.

Assembling the Drag

In Fig. 33 the mold is shown at *D* bottom up on the truck *E*. The pattern plate is in position on the machine. Two of the horn gates *A* have been removed and replaced on the pattern. The remaining four are partially withdrawn from the mold. The depressions for the strainer cores are shown at *B*. The prints *F* are also loose and come away from the pattern plate with the mold. When the drag is ready for assembling, cast-iron bushings are placed in the cylinder-core prints in the mold. The insides of these are a nice fit for the





FIGS. 30 AND 31. CYLINDER BLOCK READY FOR CLEANING AND DRAG PATTERN IN PLACE ON ROLL-OVER MACHINE

AUTOMOTIVE CONSTRUCTION

barrel cores. Formerly four men could put up about 40 of these drags a day but under our present system two men can turn out about 75 in 10 hours.

In Figs. 30 to 33 inclusive similar reference letters have been used for similar parts. Next in order of assembly comes the large cheek.

THE PATTERN AND MOLD

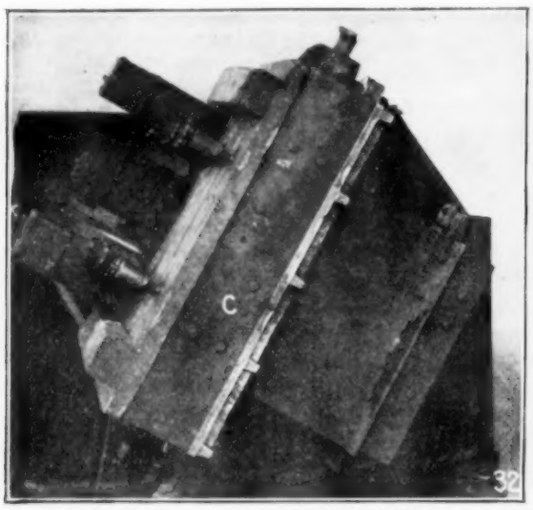
In Fig. 34 the pattern and mold for this part are shown just after the drawing of the pattern. Numerous chills are placed in this mold. They are rammed up along with the pattern and come away from it as loose pieces but unlike ordinary loose pattern parts they remain in the mold. They can be seen at *A* in Fig. 34, the parts *B* being loose pieces of the pattern. The chills marked with an *X* are more readily seen in Fig. 35. The production on this part is slightly less than on the drag; it requiring three men to turn out 75 molds in 10 hours.

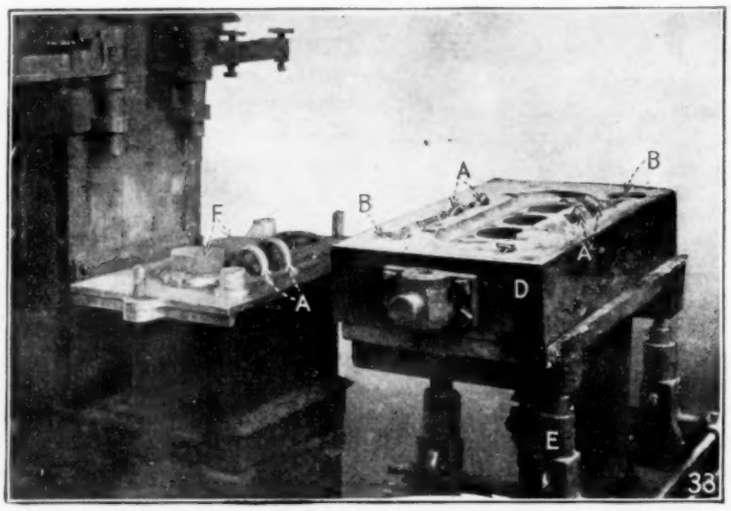
The small cheek is shown in Fig. 36. There is some similarity between this and the large cheek with the exception that there are more loose pieces in the small cheek than in the large, but the production is greater and is similar to that of the drag, two men being able to put up 75 molds in 10 hours.

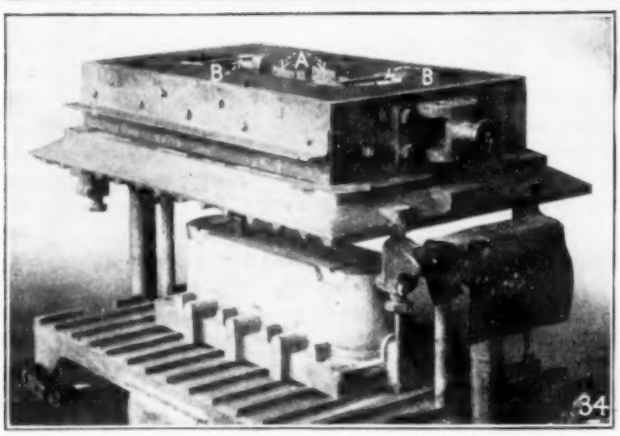
By far the most difficult of all the parts is the cope mold, the pattern for which is shown in Fig. 37. At *A* in each corner are the pouring gates and at *B* the risers. At *C* is a loose print for a core which is inserted from the top of the cope. The members *A*, *B* and *C* lift with the mold when it is parted from the pattern. At this point it may be well to call attention to a feature which so far has been ignored. As previously stated all sets of patterns are made in exact duplicate and when in place for molding they occupy exactly the same position with relation to the pilot pins on the molding machine. It is perhaps needless to say that the pilot pins *D*, on the various machines are located with great care so that lengthwise and crosswise center lines of all patterns on all the machines are coincident. If the patterns are accurate, this insures duplication of molds, providing the holes in the flasks for the pilot pins fit accurately. This feature is obtained by babbitting the holes while the flasks are in place in the molding machine.

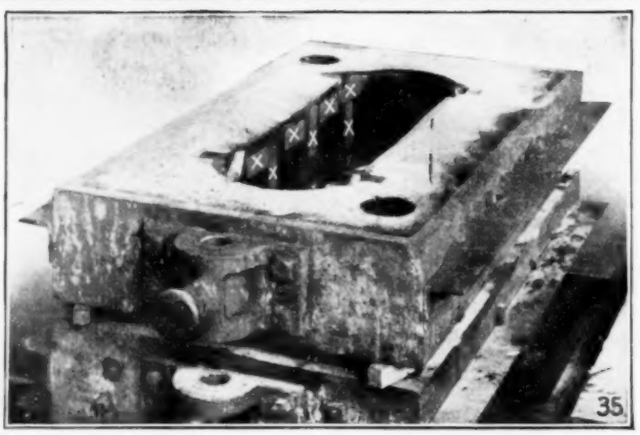
In Fig. 38 the mold is shown after it has been rammed up and one-half of the gates and risers have been removed.

In Fig. 39 the mold is shown stripped from the pattern and ready for removal from the machine. After









FIGS. 32 TO 35. MAKING THE DRAG AND CHEEKS

Fig. 32—Rolling the drag-mold over. Fig. 33—Drag-mold with loose pieces partly removed. Fig. 34—Battery and mold of large cheek. Fig. 35—Large cheek mold.

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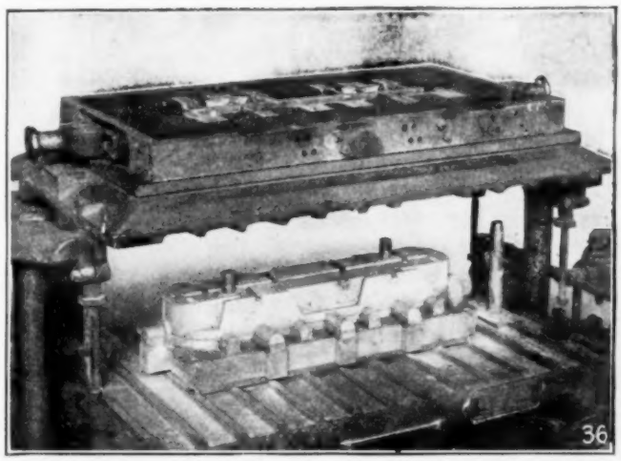
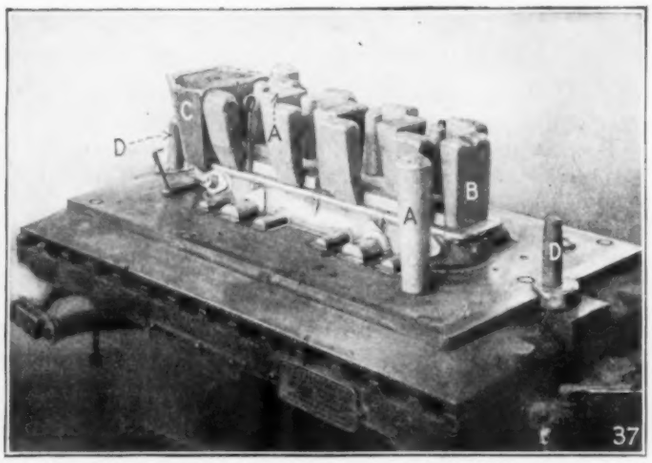
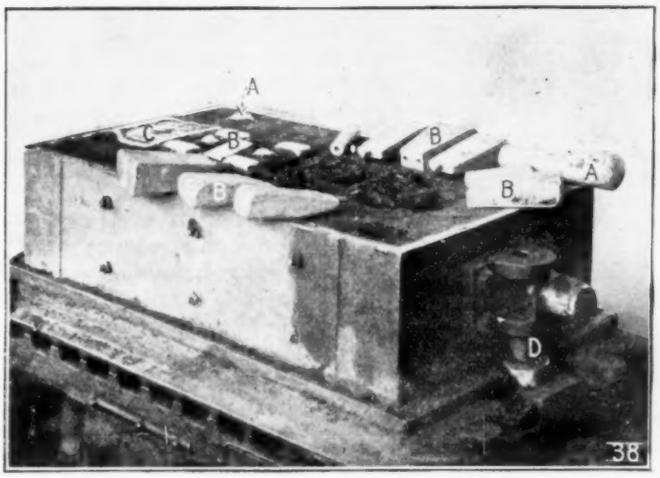
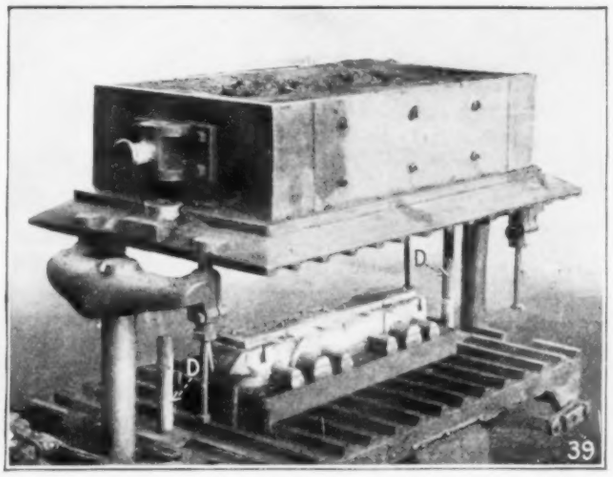








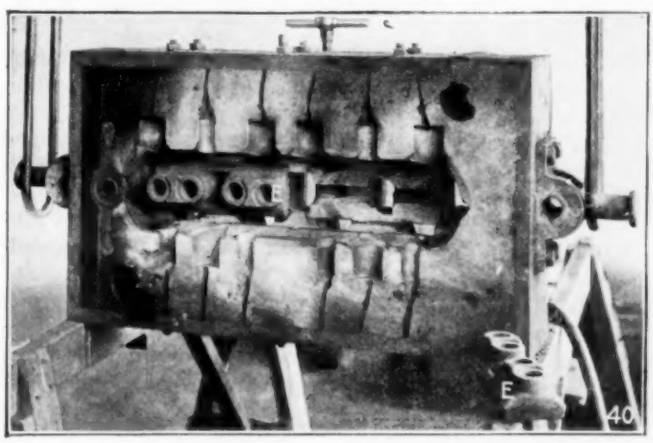
FIGS. 36 TO 39. MAKING THE COPE

Fig. 36. Small Cheek Drawn From Pattern. Fig. 37. Cope Pattern in the Molding Machine. Fig. 38. Mold Rammed and Part of Risers and Gates Removed. Fig. 39. Stripped From the Pattern.

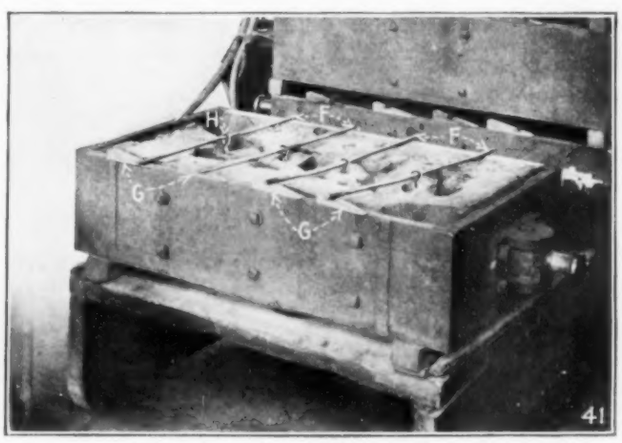
removal from the machine the valve guide cores are placed and hung by wires from rods across the flask on the outside.

In Fig. 40 is shown the cope mold turned up on its side to show how the valve guide cores are placed. One of the cores *E*, is shown in place in the mold, and the other is shown on the trestle. Wires *H*, Fig. 41, are strung through the core irons in the cores, passed through to the back and twisted around the rods *F*. Proper tension on the wires is obtained by inserting wedges *G* under one end of each rod *F*. Three men make up 50 cope molds in 10 hours.

All the molds for drags, cheeks and copes are made up and stacked by the various gangs ready for the mold assemblers whose work will be described in the next article.



COPE MOLD WITH ONE VALVE GUIDE CORE SET



COPE MOLD WITH ALL VALVE GUIDE CORES SET

AUTOMOTIVE CONSTRUCTION

Automotive Ordnance Apparatus With a Wide Field of Usefulness

Among the various automotive units shown by the Army Ordnance Department at the summer meeting of the Society of Automotive Engineers at Ottawa Beach were the two illustrated. Fig. 1 shows the small mobile machine shop which was found to be very valuable in the campaigns in France. The shop is mounted on a motor-truck chassis and generates its own power for the various motor-driven machine tools. The tools include a universal milling machine, a small drilling

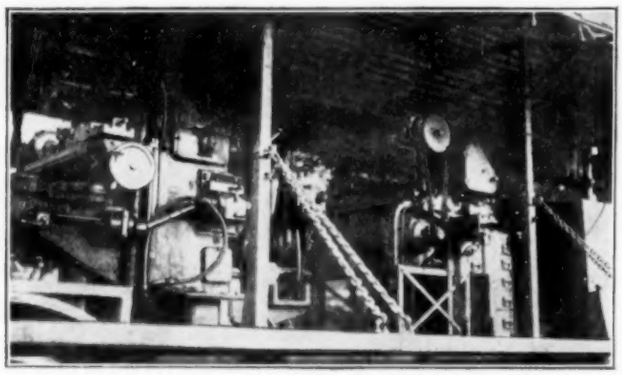


FIG. 1. SMALL MOBILE ORDNANCE MACHINE SHOP

machine, an engine lathe and a tool-grinding stand. There is a substantial bench and a full equipment of tools is carried in lockers.

These outfits were used for making minor repairs on all sorts of ordnance equipment and their efficacy is shown by the fact that in some engagements more than 95 per cent. of the American artillery on the line was in serviceable condition while the percentage ran as low as 50 in the Allied services.

Fig. 2 shows an automotive crane on a track-laying type of tractor chassis. The crane is shown lifting one of the three-ton tanks by the lifting rings provided for that purpose. The tractor is also provided with a winch which may be seen at the foot of the crane.

With the type of tread fitted to this machine, its usefulness is not limited by the nature of the ground over which it must work, as it can go practically anywhere. The low bearing pressure of the tracks permits of use in soft mud or snow where any other vehicle would be hopelessly mired.

FIG. 2. AUTOMOTIVE CRANE ON CATERPILLAR TRACKS

Selecting High-Speed Steel Scrap for Conversion

BY SAMUEL S. BUCKLEY
President, Onondago Steel Co., Syracuse, N. Y.

Steel that is not high-grade high-speed steel; that is, steel of 14 per cent. tungsten content or under, is not acceptable for conversion; nor are drills, reamers or other tools having soft-steel shanks or soft-steel parts. This latter objection can be frequently remedied by breaking off the soft-steel parts.

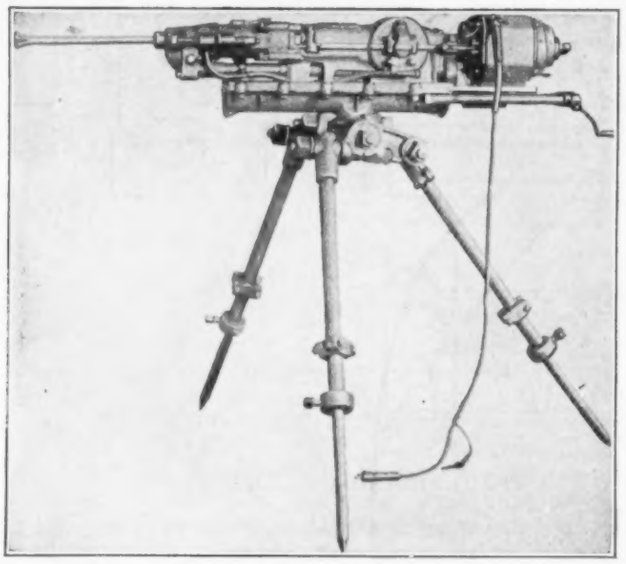
It is also impossible to use high-speed-steel scrap that contains copper or brass as in oil-tube drills, spelter on brazed tools, soldered tools, or scrap which might carry any other of the non-ferrous metals. The reason for this is that these metals cannot economically be removed from the high-speed-steel scrap, and in melting cause an upset that destroys the value of the steel.

The writer suggests that in separating high-speed-steel scrap from other steels, a soft, free-cutting fine-grain alundum or corundum wheel be used, running dry and at the speed recommended by the maker. The wheel should be located in a dark place. Take samples of high-speed steels of known quality, familiarize yourself carefully with the sparks produced by these samples, and note particularly the color of the spark, the distance at which it explodes from the emery wheel, and the shape of the spark when it explodes.

The term "explosion" might be explained in this way: high-speed steel when ground on a dry wheel throws a spark that has the appearance of a dull-red line for some little distance, and that line shows an explosion at from 6 to 20 in. from the point of contact with the wheel. In such an explosion, some high-speed steels show a bright, but not brilliant star effect, while others seem to break up into lines similar to the line running down from the point of contact.

In developing a working knowledge of this spark test, it is well to familiarize yourself with the sparks shown by the various grades of self-hardening and other tungsten-alloy steels, as well as cast iron, so that you will be able to throw out the steels or iron that have a spark slightly similar to true high-speed steel. In testing a gray-iron casting, it will be noted that the spark is a very dull, almost invisible red, with practically no explosion. With the Mushet type of self-hardening steel, the spark is a lighter red, a little more pronounced, and has a slight tendency to open up at the end of the stream, but not into what would be termed an explosion. There are special grades of self-hardening steel that are lower in tungsten and chromium and which show a lighter spark. After these comes what is termed semi-self-hardening steel, known to the trade as double-special or finishing steel, having a still brighter spark, and lighter-red stream. There is also on the market a 1- to 2-per cent. tungsten steel for tools, and other steels used for what are termed, "high-speed-steel hacksaws." These show a spark that has to a great extent the appearance of a carbon-tool-steel spark in its scintillating character, but the stream of the spark is darker, and the explosion shows a darker color. Straight carbon steel shows a white brilliant spark exploding but a few inches from the point of contact with the emery wheel.

Pneumatic - Electric Rock Drill and Some of the Tools Used in Its Construction—II



By FRANK A. STANLEY

Operations on the Smaller Parts

Many of the minor parts as well as the casing and larger castings used in the construction of the machine under discussion are made of chrome-vanadium steel, the shock-resisting qualities of this material being of especial value in machinery that is subjected to such severe usage as falls to the lot of a rock-drilling machine. Special jigs and fixtures are provided for many of the operations involved in the finishing of the parts for the rock-drilling machine.

THE crosshead is shown in Fig. 11 and the sequence of operations followed in its manufacture are as here given.

Operation 1.—Saw from bar in lengths of 14 1/16 in. (four pieces).

Operation 2.—Mill the face *A* and the 1⅜ in. slot, ⅞ in. deep.

Operation 3.—Mill the sides *C* and *D*.

Operation 4.—Mill grooves *E* and *F*.

Operation 5.—Saw the bar in two pieces each seven inches long. Use a metal saw one-sixteenth inch thick.

Operation 6.—Drill out the stock in the gap at *G*.

Operation 7.—Saw in two pieces 3 15/32 in. long. Use saw one-sixteenth in. thick.

Operation 8.—Mill the gap *G*.

Operation 9.—Shape corner K in the shaping machine. The fixture holds two pieces.

Operation 10.—Bore and thread the piston-rod hole in lathe, use fixture, Fig. 12.

Operation 11.—Bore and ream the wrist-pin hole.

Operation 12.—Saw out the corner at *L*. Hold the work in the vise.

Operation 13.—Drill and tap for cap bolts.

Operation 14.—Caseharden the guide faces.

Operation 15.—Polish the guide faces. Clean off the scale.

Operation 16.—True up the piston-rod hole in the grinding machine.

Operations 1 and 2 require no special fixtures. Operations 3 and 4 are performed with the aid of milling fixtures in which the pieces are located from the 1⅜-in. slot which has been cut through the length of the bar in operation 2. They are straddle milled upon surfaces *C* and *D* in operation 3, while in operation 4 the undercut portions *E* and *F* of the guide channels are milled.

Operation 5 is the sawing of the bar into two pieces each long enough for two cross heads, or 7 inches over all. In operation 6, stock is drilled out to form the fork at *G*.

The pieces are again divided in operation 7 so that from this point forward they are handled as individual crossheads.

Operation 8, milling the gap in the crosshead is accomplished with a special fixture in which the block with the holes bored through it is clamped against an upright surface and located by a tongue which fits the 1⅜-in. slot milled in operation 2.

The finishing of the rounded corner *K*, Fig. 11, is next attended to in operation 9, which is performed in the shaping machine, two pieces being done at once.

Lathe Work

The boring and threading of the hole for the piston rod is attended to in operation 10 with the fixture shown in Fig. 12. This is a faceplate attachment which is shouldered for central location on the faceplate and provided with a right-angle seat for holding the crosshead to be bored. The seat has a steel guide which fits the wide T-slot under the bottom of the crosshead. This seat is the exact distance from the center required for the height of the piston-rod hole above the bottom of the crosshead, thus bringing the work into position for the boring and threading operations.

The piece is secured in place by a strap passing over the top and held by two nuts on studs tapped into opposite sides of the base.

The boring and reaming of the taper wrist-pin hole crosswise of the crosshead, operation 11, is done on a similar fixture, differing only in respect to the locating tongue which is here placed crosswise to bring the crosshead to exact right angles. The taper hole is produced by boring with the taper attachment and then reaming to size.

The connecting-rod is machined from a chrome-van-

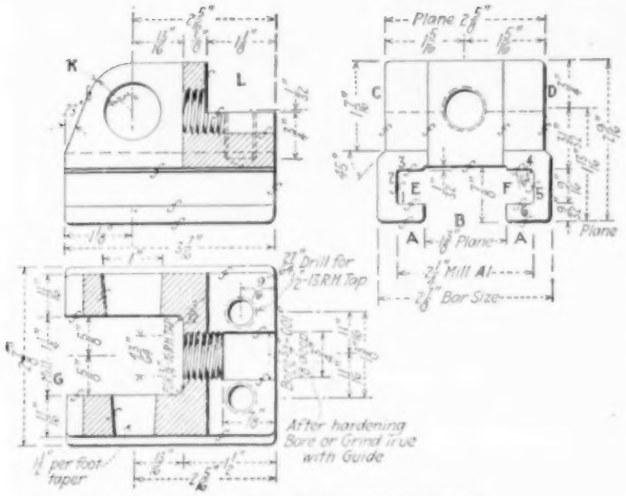


FIG. 11. DETAIL OF CROSSHEAD

adium-steel drop-forging containing from 15 to 20 point carbon. The finished rod ready for the strap is shown in Fig. 13 with numerals designating the order of operations.

Operation 1.—Hand-grind face 1 flat.

Operation 2.—Machine face 2 and 3 to dimensions given. Use lathe fixture, Fig. 14.

Operation 3.—Drill and ream wrist-pin bearing 4.

Operation 4.—Mill faces 5 and end 6 to dimensions given.

Operation 5.—Mill faces 7 to dimensions given.

Operation 6.—Drill oil chamber 8. Use jig Fig. 15.

Operation 7.—Drill bolt hole 9. Use jig Fig. 15.

Operation 8.—Drill and counterbore 10. Use jig Fig. 15.

Operation 9.—Drill oil hole 11. Use jig Fig. 15.

Operation 10.—Drill oil hole 12. Use jig Fig. 15.

Operation 11.—Caseharden 5; draw to 400 deg. F. in oil; cool slowly.

Operation 12.—Lap wrist-pin bearing.

Facing in the Lathe

After the grinding of the face is done by hand the rods are faced in the lathe fixture shown in Fig. 14, where six rods are set at one time and the faces machined simultaneously. The rods are set in place by first bringing their inner ends against a setting plug which is slipped into the bore of the fixture. This setting plug is 3 in. in diameter on the body and therefore the inner ends of the work are spaced about a circle of that size. This prevents the lugs on the rods from coming in contact with one another and also provides a suitable-sized opening between the work ends for the admission of a hooked tool to face the underside of the rod ends.

The height of the supports cast on the fixture is sufficient to give ample clearance between the work and the face of the fixture for the tools to operate. There is in fact a little over 2 in. gap at this point, so that inside-facing tools are readily applied to both outer and inner ends of the forgings. The facing of the outside surfaces is done with a side tool.

Following the lathe operation the wrist-pin bearing is drilled and reamed and the faces 5 and end 6 are milled.

Operations, 6 to 10 inclusive comprise the drilling of various holes specified in the operation schedule, and all are performed in the jig Fig. 15. The first hole drilled is the oil chamber 8, Fig. 13, which is a $\frac{1}{4}$-in. hole lengthwise of the rod put through with the jig standing on its end.

With the jig resting upon its base the hole 9 is next drilled for the bolt. Hole 10 is drilled and counterbored with the jig in the same position, and the small oil hole at the bottom also put through to the chamber in the center of the rod. Following this the connecting-rod is tilted to the angle indicated by the dotted lines and the slanting oil hole drilled at 12.

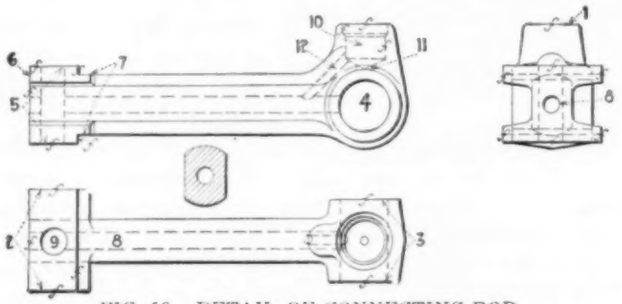


FIG. 13. DETAIL OF CONNECTING-ROD

The next operation, No. 11, is the casehardening of surfaces 5 and drawing to 400 deg. and the final operation is the lapping of the wrist-pin bearing to a clean, smooth surface.

Operations on the Connecting-Rod Strap

The rod straps shown in Fig. 16 are made from flat steel $\frac{3}{8}$ x $1\frac{5}{8}$ in. wide. The order of procedure is as follows:

Operation 1.—Cut off bar in lengths of $5\frac{3}{4}$ inches.

Operation 2.—Bend in blacksmith shop.

Operation 3.—Finish faces 1 to dimension $1\frac{9}{16}$; hold in vise.

Operation 4.—Finish one face 2 to dimension $1\frac{5}{8}$.

Operation 5.—Finish end 3 to dimension $2\frac{1}{2}$ and finish faces 4 to dimension given and $\frac{3}{8}$ in. deep.

Operation 6.—Mill faces 5 to dimensions given.

Operation 7.—Mill clearance grooves 7.

Operation 8.—Drill bolt hole 6.

Operation 9.—Score faces around bolt hole.

Operation 10.—Lathe; bore crankpin bearing 8.

Operation 11.—Case-harden *A*, draw to 450 deg. F. in oil.

Operation 12.—Lap crankpin bearing clean and smooth.

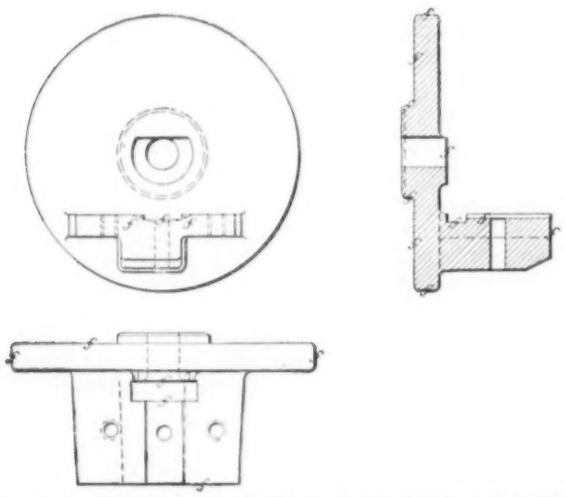


FIG. 12. LATHE FIXTURE FOR BORING PISTON-ROD HOLE

The third and fourth operations are performed in the shaping machine, the piece being held by special fixtures.

Crankshaft and Bushings

The crankshaft, which actuates the piston of the air compressor, is shown in Fig. 17. It performs its work through connection with crosshead and piston rod. and is itself actuated by bevel gearing driven from the electric motor at the rear. It is drop-forged from 20 to 25 point carbon chrome-vanadium steel and the operations required in machining it are as here given:

Operation 1.—Anneal forging; heat to 1000 to 1200 degrees.

Operation 2.—Chuck in universal lathe chuck and face ends to over-all length of 7 in., and center.

Operation 3.—Turn shaft bearings to dimensions given and face webs; use jack between webs.

Operation 4.—Mill sides of webs.

Operation 5.—Turn crankpin and face inside of webs; use centering plates.

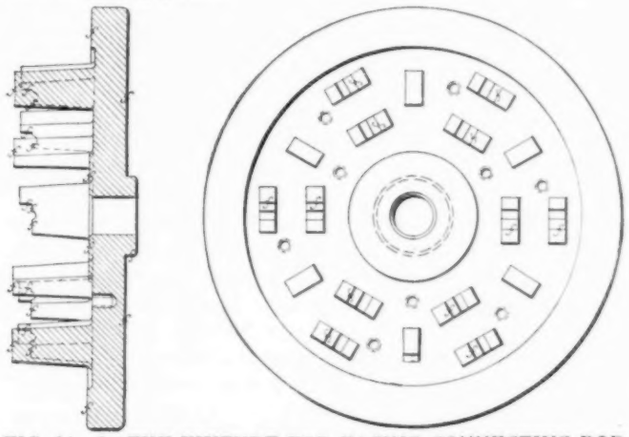


FIG. 14. LATHE FIXTURE FOR FACING CONNECTING-ROD

Operation 6.—Drill and ream hole in crankpin.

Operation 7.—Drill tap holes in webs; run tap through both webs.

Operation 8.—Drill $\frac{5}{32}$-in. hole in webs.

Operation 9.—Drill $\frac{1}{8}$-in. hole in crankpin.

Operation 10.—Drill $\frac{1}{4}$-in. hole in both ends of shaft.

Operation 11.—Heat treatment; draw to 400 deg. F.

Operation 12.—Grind crankpin; use centering plates.

Operation 13.—Grind shaft bearings; use jack between webs.

Operation 14.—Grind sides of webs.

The first machine operation which follows the annealing of the drop-forging is the facing of the ends to a length of 7 in. and the centering of the shaft ends. The shaft bearings are then turned to dimensions. The larger shoulder at one side for the bevel driving-gear fit is left 0.020 over size for grinding.

This third operation includes the facing of the webs on the outside, a jack being used between the webs to stiffen the work and prevent distortion. The jack is a neat little device with a short thread fitting a squared nut with concave bearing face to give edge contact with the work, and the head of the jack carries a similar-shaped washer, or collar, which takes a like bearing against the inner face of the opposite web.

Milling the sides of the webs is accomplished in special fixtures in which the work rests in horizontal V-blocks with the crankpin resting upon a supporting pad at the correct height to bring the work with the tops of the webs level.

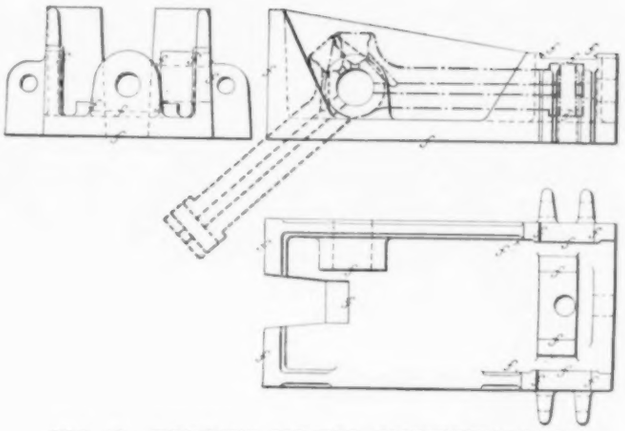


FIG. 15. DRILLING JIG FOR CONNECTING-ROD

Operation 5 consists in turning the crankpin and facing the inside of the webs, work that is greatly facilitated by centering plates which fit over the turned diameters of the crankshaft bearings and which are planed out to form a rectangular seat fitting over the sides of the webs. These webs are milled so that they will just fit the seats in the plates and $\frac{1}{4}$-in. screws are tapped through the sides of the latter to hold them in place on the work. The locations of the off-set centers in the plates are on the longitudinal center line so that the two will be precisely opposite when attached to the crankshaft; thus it is obvious that the work will be accurately turned with its pin in the correct relation to the main bearings and webs. The pin is turned 0.020 larger than required, leaving that amount for grinding.

Operation, 6 to 10 are drilling operations performed in a special jig. The first thing is to drill and ream the $\frac{7}{16}$-in. hole in the crankpin, which is done with the jig standing on end. At the same position $\frac{21}{64}$-in. holes are drilled in the webs for tapping to $\frac{1}{2}$ in. The tap is run straight through both webs from this side after the drilling operations are completed.

Two $\frac{5}{32}$-in. holes are drilled down from the edges of the webs with the jig on its side, and in the same position the $\frac{1}{8}$-in. hole is drilled crosswise of the crankpin.

In the heat treatment which forms operation 11 the crankshaft is drawn to 400 deg. F.

Then for operation 12 the crankpin is ground on the cylindrical grinding machine with the aid of the same set of centering plates, as previously used when turning the pin.

Following this the shaft bearings are ground to finished diameter, the limit of accuracy being 0.0005 in., and the shoulder for the driving gear is ground to the same tolerance. The grinding is done with a jack placed between the webs.

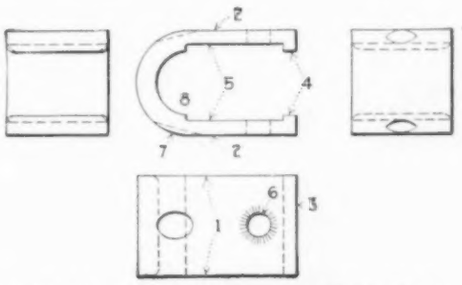


FIG. 16. THE CONNECTING-ROD STRAP

The Lumen bushings in which the crankshaft runs are flanged at the inner end to seat against the wall of the gear case, and the flanged surface provides a thrust for the crank web and the bevel driving-gear hub on the opposite end of the shaft. The bushings are turned and bored in the lathe.

In connection with the bushing work there are many other jigs that, while each is of course designed to accomplish its own particular object, are all built upon

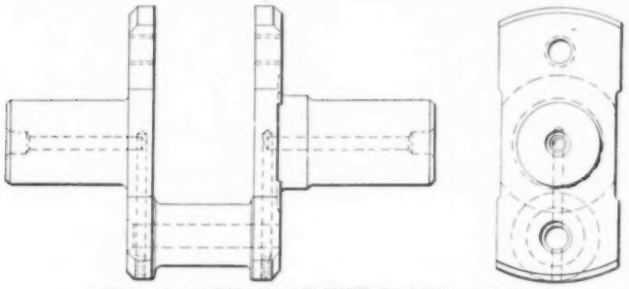


FIG. 17. DETAIL OF THE CRANKSHAFT

the same general principal and further illustration would serve no purpose.

The object of the foregoing description has been to give a general idea of the construction of a machine that is a radical departure from the usual type and to illustrate the careful and painstaking methods used in its construction to insure rigidity, long wearing qualities and interchangeability of parts.

Share Your Knowledge with the Other Fellow

By W. H. Addis

Millions of dollars are carried to the wrong side of our industrial ledgers each year, because so many bright, capable men have no talent or inclination to impart to others the knowledge they possess and some who have the ability to do so refuse because they have a wrong conception of their duty.

Time and again I have met men possessed of superior information who refused to impart it to those it would have greatly helped. I recall one occasion where a young apprentice was allowed to throw in the back gears of his lathe while the spindle was running. The gearing was a wreck, while all about the dumbfounded lad machinists were working who would not put forth a hand to warn him.

Then there was the case of George, the repair man in a small machine shop. George had the good fortune to be a "bear cat" at interpreting the mysteries of the Jones & Lamson headstock mechanism. Would he help the operators by putting out a little of his wisdom? Not a bit of it. Let them break them up! That made business good for George. He might have been of great help to the boys in that shop if he had so chosen, and incidentally have made himself very valuable to the company.

In the same plant a pattern-room foreman was employed who had degenerated by the John Barleycorn route from the position of metallurgist with a large bronze founding concern. He was a wizard at compounding formulas and mixtures for bronze and malleable iron. One day he came to me and said: "Addis, those dubs over there at the malleable works have shifted the decimal point in their phosphorus content and are using ten times as much 'phos' as they should!" Did he warn them? Never! Let them worry it out. That wasn't his job.

And so it goes. Wherever one travels, there is always to be seen great ignorance prevailing regarding even the first principles of shop practice. In some of the best "systematized" shops in the country the average drilling-machine operator has not the least idea what a properly ground drill should look like.

What is really needed today is a revival of the old-time apprentice instruction by which a boy is everlastingly taught how and why to do things. The brightest spots in my shop experience are those made by the sometimes rough but ever-kindly men who were everlastingly trying to keep me from "balling the job." As I look back in reminiscence there comes to mind my first foreman, a man who was always telling me why he did everything just so, and why I should do likewise. A cape chisel must be ground "like this"; and a parting tool could be kept from gumming up with chips and breaking by cutting the "part" just a little wider than the tool. For four years he daily taught and systematically cursed the trade into my head. And when our last day together came (it was when I hit him on the head with a 2-lb. hammer for calling me a bad name because I let some steel chips fall into my lathe pan which was then partly filled with brass turnings) he, faithful to the last, cursed me out of the shop and into a better job; but he quit a teacher.

And there also comes to mind a host of good fellows, machinists, toolmakers, foremen, designers, and engineers, who were always ready to pass along the helpful word to one who was willing to receive it.

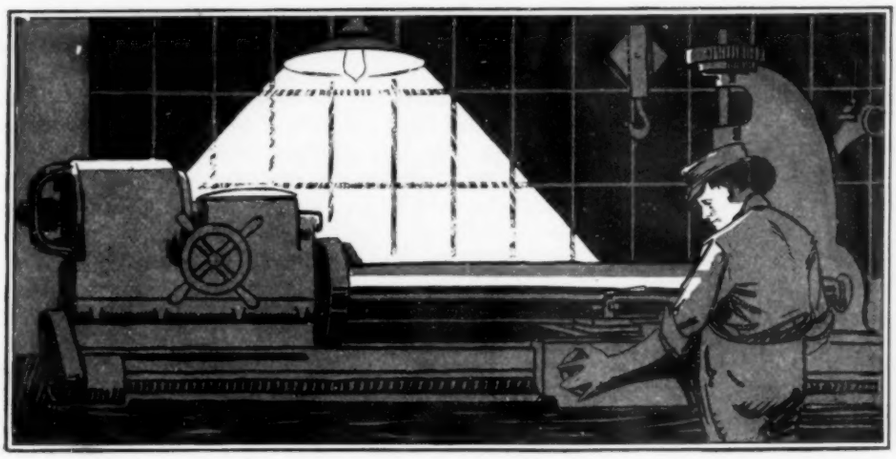
We are all learners in the industrial school of life. Everything we know has come to us second hand. It is only as we receive, adapt, and pass on the product of other men's study that we really grow.

During the war I recall the visit of a Government representative to a plant to persuade them to adopt a system of war-time training. In answer to his appeal, the superintendent said, "Why, man, this whole plant is a most successful school now! Every foreman in the works is a teacher, every workman a pupil, and the plant is the classroom. We don't need any help in establishing educational supervision. It is a reality here."

There is no place in American industry for the foreman that cannot teach his men. Men—free men—follow only one thing; that is intelligent leadership. The foreman who knows how to do his work in the best way and can tell his men why he does it so that they will be able to follow his instruction, is a success. Men can, and will, follow him.

The machinist who is constantly imparting knowledge to his fellows and doing it agreeably, is himself growing faster than they. Already he has begun to step upward from the ranks. This is the surest way to promotion. To know how to do a thing better than someone else places upon a machinist a certain obligation to help the other fellow do as well, and when he does that the employer profits and he in turn can afford to make the machinist-teacher profit. So it is true that he profits most who serves best.

This is the spirit of efficiency that will most surely place the American machinist and artisan in his place in the sun. In no other way may we achieve success. We are obliged to help each other; to help all with whom we work, and in direct ratio to our willingness and ability to do this we shall prosper.



LIGHT, ELECTRICITY and The Shop

By C. E. Clewell

Notes on the Control of Alternating Current Motors

This article relates mainly to methods of starting alternating-current motors and induction motors of the squirrel-cage and slip-ring types. Brief reference is made to the effects of reduced voltage in starting induction motors. The discussion also includes some information relative to magnetic brakes, with more direct reference to brakes for motors of alternating-current type.

PROBABLY the aggregate horsepower of induction motors in the industries is larger than of any other single type, and hence it is of consequence to look into the methods for their control. It will be considered for simplicity that the three most important functions of the controller are starting, stopping and speed adjustment, the other functions of motor protection, remote-control attachments, and so on, which are so often made a part of the modern control equipment, being treated as secondary items.

First, it may be stated that the squirrel-cage motor possesses such operating characteristics that if it is connected directly to the supply circuit it takes such an excessive current in starting that injury to the motor itself is likely and serious disturbances to the supply voltage are also probable, the latter feature usually being objectionable to other devices supplied from the same circuits.

Secondly, this type of motor, after it is operating at its normal speed, tends to run at a speed that is essentially constant in value at all loads from zero to full load. As a matter of fact the drop in speed from no load to full load is so small that this motor is classed as a constant-speed type for all normal loads.

FIG. 1. STARTER FOR ALTERNATING-CURRENT INDUCTION MOTOR

The power supplied to the induction motor enters the motor through the stationary-field structure, and not through the rotating element (known commonly as the rotor) as is the case with the direct-current motor where the power supply enters the rotating armature through the commutator. Current flows in the rotating element of the induction motor, it is true, but it is not directly conducted into the wires of the rotor, but is induced in it by the action of the alternating supply in the stationary-field winding, inside of which the rotor revolves. This action of induction is the basis for the name of this type of motor.

In order to keep the initial inrush of current into the motor to a low value at starting, some scheme must be employed for minimizing this effect. The scheme, as commonly used for induction-motor starting, is to reduce the voltage applied to the terminals of the motor during the starting period. This is accomplished readily by taking advantage of the ability to change the supply voltage to a lower value by simple transformer action.

Briefly stated the starter for the induction motor consists essentially of a transformer connection so arranged that the voltage applied to the motor terminals is reduced during the starting interval, and then, by throwing the starting handle to its other position, in one or more steps, the full supply voltage is applied to the motor. Such a device is known as a starter, an autostarter or a starting compensator.

While the starter just described reduces what would otherwise be an excessive inrush of current at starting, the reduced voltage applied reduces very largely the starting torque of the motor. Hence, in gaining the advantage of reducing the starting current by such

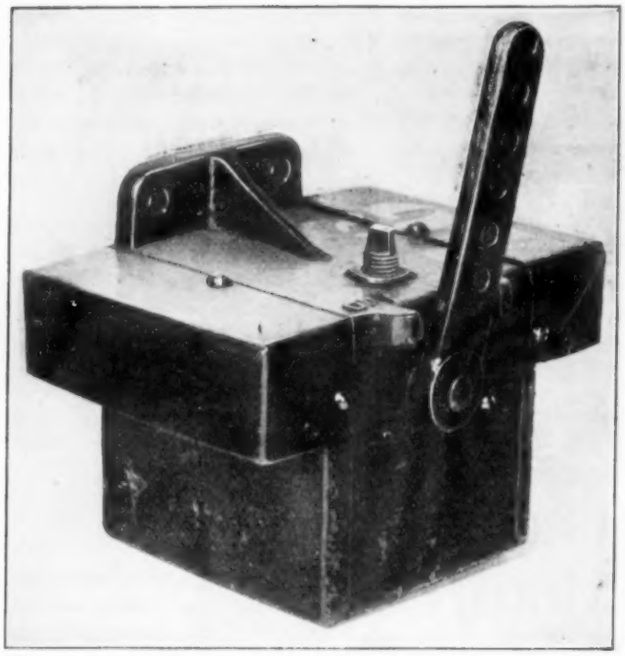


FIG. 2. A LOOM-MOTOR SWITCH FOR ALTERNATING CURRENT

means, there is a corresponding disadvantage due to the reduced torque available for starting the load. This makes it necessary to strike a compromise; that is, to use a voltage sufficiently below that of the supply circuit to keep down the starting current to a satisfactory value and at the same time to keep it up to a sufficiently high value to insure that the starting torque will be sufficient to start up the load on the motor.

Reduced Voltage Practice

To illustrate the practice of controller manufacturers it may be stated that one make of autostarters and autostarter switches is connected normally for starting squirrel-cage motors at 65 per cent. of the full-line voltage, and after the motor speeds up the full-line voltage is applied and the motor continues to operate at normal pressure. Provision is made for changing the connections so as to obtain a starting pressure of 50 and of 85 per cent. of full-line voltage in case unusual conditions of operation should make it desirable to depart from the usual practice.

Another method for keeping down the starting current and at the same time obtaining a strong torque

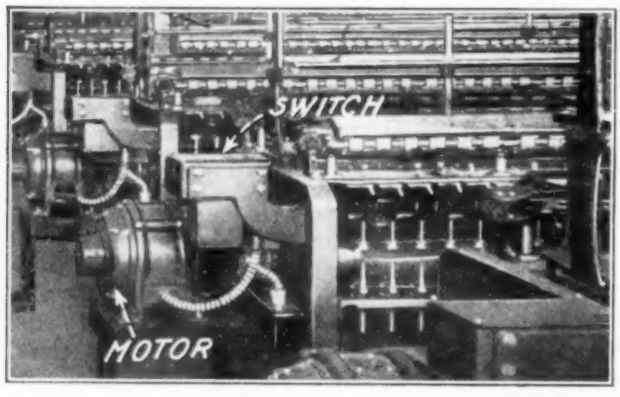


FIG. 3. ALTERNATING-CURRENT INDUCTION MOTORS IN A TEXTILE MILL

for starting purposes is to make use of the so-called slip-ring induction motor. This type, as its name implies, has slip rings mounted on the motor shaft, on which brushes slide as the motor rotates. To these brushes an adjustable auxiliary or external resistance is connected, and the starting operation consists of inserting a high external resistance in the rotor circuit, after which the field, or primary coils, of the motor are connected to the supply circuit.

The motor then starts under conditions that result in large mechanical starting effort and low starting current. As the motor speeds up, the external resistance is reduced in steps quite similar to the method employed in starting an ordinary direct-current motor by a starting rheostat. Under normal operating conditions all of this external resistance is cut out by means of the controller.

The speed control of induction motors is very limited.

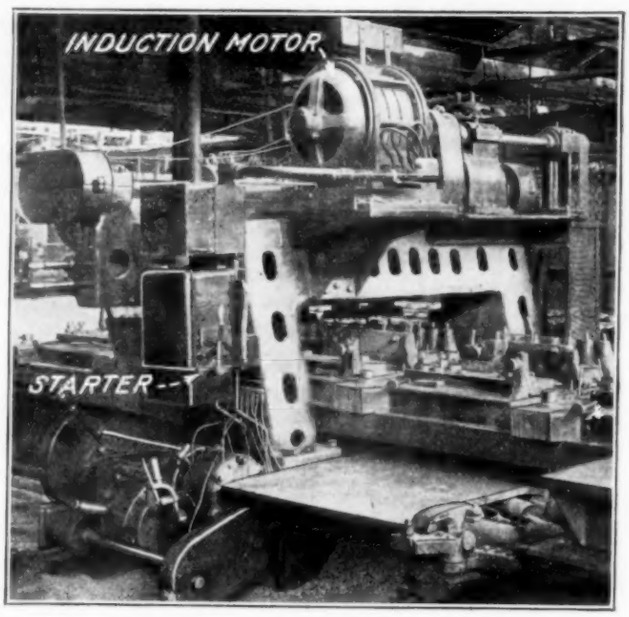


FIG. 4. AN INDUCTION MOTOR DRIVING A MILLING MACHINE

In fact the requirement that a machine be driven by a motor capable of wide speed changes and with such characteristics that when set for any given speed this speed shall be maintained constant at all normal loads can be met successfully only by the direct-current adjustable-speed motor. The induction motor is almost entirely employed for machinery that operates at constant speed or where the desirable speed changes are obtained through mechanical speed-changing devices.

The squirrel-cage motor has an inherent operating speed that depends on the frequency of the supply circuit and on the number of poles of the motor. As stated above the speed of such motors remains practically constant at this inherent value for all loads. The frequency, 25 or 60 cycles per second, as the case may be, is fixed by the supply generators in the power house, and as the purpose of the supply is to maintain constant voltage and constant frequency at all times there is practically no possibility for speed changes by varying any of these elements of the supply mains.

However, it is possible to secure say two different speeds for an induction motor by so connecting its field windings to a two-position switch that the number of

poles of the motor may be changed. Thus a four-pole motor which runs at a speed of 1800 r.p.m. could be made to operate at half this speed if the poles of the motor are changed through special connections to a switch so as to increase the poles to double the original number. This scheme, however, is very limited, since to make more than one change in the number of poles results in too complicated an arrangement to be practicable.

Varying the Resistance of Rotor Circuit

With the slip-ring motor it is possible to secure different speeds for a given load by the manipulation of a controller so arranged as to throw more or less auxiliary resistance into the rotor circuit. In other words, the motor slows down more for a given load with high resistance in the rotor circuit than it does for the same load and a lower resistance in the rotor circuit.

This scheme, therefore, may be used to a limited extent for obtaining different speeds, but it is open to the objection that the speed when set for any given

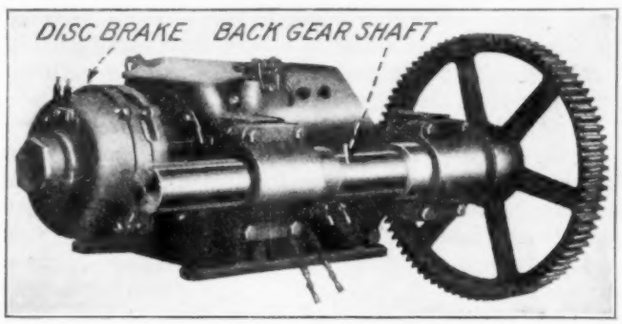


FIG. 5. A MOTOR PROVIDED WITH A DISK BRAKE

value by such external resistance varies over much greater limits as the load changes than would be the case for the same load changes if there were no auxiliary resistance in the rotor circuit.

Other methods of speed control for the induction motor include those whereby the supply voltage is modified to lower values or the frequency of the supply is changed. The first results in very inefficient operation of the motor at low speeds, and the second is impractical because of the great difficulty in changing the frequency of the supply for each motor in service.

Reversal of the Motor

From what has been stated it will appear evident that there is no good scheme for wide speed adjustment with close speed graduations with induction motors as is the case with the direct-current adjustable-speed motor, so that alternating-current motors are generally limited to constant or practically constant speed.

Reversal of the direction of a polyphase induction motor may be accomplished by changes in the connections to the primary or field winding of the motor. Thus for a two-phase, four-wire motor the two wires of either of the phases if interchanged will reverse the motor. With a two-phase, three-wire motor reversal is accomplished by an interchange of the two outside wires leading to the motor. In a three-phase motor reversal is accomplished by interchanging any two of the three wires leading to the motor. The changes just mentioned may be made through a special switch arranged so as to make the necessary changes of connection by a simple throw of the switch from one position to another or they may be made by changing the connections where the wires enter the machine.

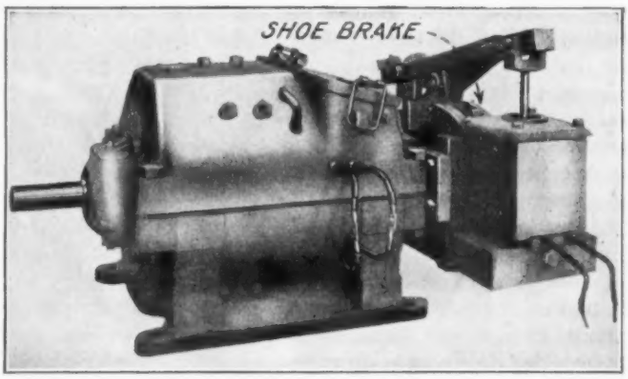


FIG. 6. A MOTOR EQUIPPED WITH A SHOE BRAKE

Fig. 1 indicates one form of starter switch for induction motors in which fuses are a part of the starting unit. The operating handle is seen at the top of the device.[1]

Among the numerous cases where the induction motor has proved useful is that of the textile mills. Fig. 2 shows a loom switch for throwing in the motor to the line, and in Fig. 3 a practicable installation of induction motors is shown with the switches located near to each motor. An example of an induction motor employed for the operation of a large milling machine is illustrated in Fig. 4. This view also shows the location and general appearance of the starter for such a motor.

Brakes for Motors

Magnetic brakes are available in several types, one of which, illustrated in Fig. 5, is of the form known as a disk brake, used merely for retarding the momentum of he moving apparatus and usually designed to hold about one-half of the full-load torque of the motor. Brakes of the magnetic type can be secured so arranged as to exert their braking effect only at such times as the motor is not taking current from the line, and to be released as soon as the motor again begins to receive current from the supply mains.

[1]Fig. 1 is due to the Crocker-Wheeler Co., Fig. 2 to the Wagner Elec. & Mfg. Co., Figs. 3, 4, 5 and 6 to the General Electric Co., and Fig. 7 to the Westinghouse Elec. & Mfg. Co. The writer is indebted to each of these companies for information relative to the various types of equipment.

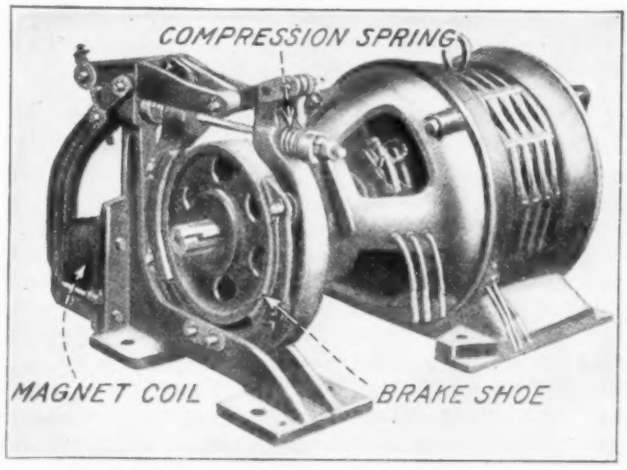


FIG. 7. A MAGNETIC BRAKE APPLIED TO AN ALTERNATING-CURRENT MOTOR

Another type of magnetic brake, Fig. 6, is that known as the shoe brake, usually designed to exert a braking effect equal to the full-load torque of the motor, though it may be adjusted for holding a higher or lower value than that corresponding to full-load torque. One of the features of this type of brake is that it utilizes wheels of steel with small dimensions, shoes of metal, and the magnetic coils are inclosed and made self-adjusting in the sense that as the brake shoes wear away, the air gaps, which determine the magnetic pull, stay constant and hence maintain a constant braking effect throughout the life of the brake shoes. Fig 7 gives an illustration of a brake that is especially designed for alternating-current motors to afford a quick stop without shock to the mechanical system, and is capable of holding whatever load is attached to the motor. Brakes of this type are particularly useful for motors that operate cranes and hoists or other loads where frequent stops and reversals of motion take place. A so-called clapper type of magnet, similar to those used in some magnetic contactors for controllers, is used in the brake, the design being such that the armature, which is the only part of the magnet that moves, has a motion as small as from $\frac{1}{4}$ to 1 in. The brake automatically exerts its braking effect when the power to the motor is shut off, and is released as soon as the power is applied to the motor again.

Among the advantages of a brake of this type are that it is suitable for operation on any horizontal motor and in any vertical position and hence does not depend upon gravity. The strong compression springs produce a smooth braking effect, and the braking action is the same for either direction of motor rotation.

Up to 550 volts the coils may be connected directly to the supply circuit, transformers being used for voltages higher than this value. The action of the brake on releasing is positive even if the line voltage should be as much as 20 per cent. below normal. If the brake shoes are allowed to wear too far without replacement the brake merely fails to release, this being a safety feature to prevent a load from slipping. Any replacements or adjustments can be readily made.

Special Boring Machine for Railway-Motor Shells

By J. Wright

After years of constant service in street-railway traffic, the bearing seats of electric-motor shells which carry the axle and armature bearings become so worn that they must be rebored. The Chicago Surface Lines had about 3000 motors in service the bearing seats of which required this treatment, and as there are four of these seats in each shell the problem of economically reboring them led to the purchase and equipping of a special Beaman & Smith boring mill, shown in Fig. 1, which had been used for boring gas-engine cylinders.

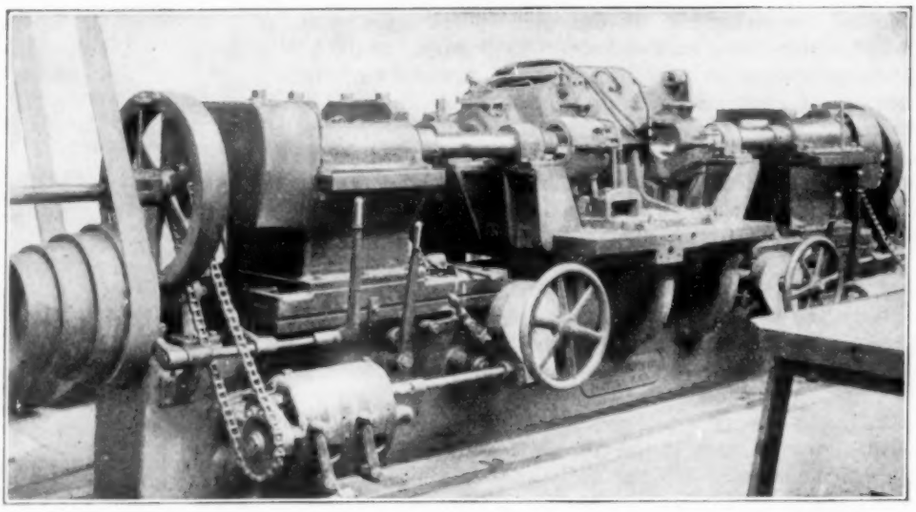


FIG. 1. FOUR-SPINDLE BORING MILL FITTED FOR ELECTRIC MOTOR SHELLS

After its purchase by the Chicago Surface Lines it was remodeled and fitted with four boring spindles correctly positioned with respect to the bearing seats of the motors it was intended to rebore, each spindle being furnished with a Davis boring bar, provided with an expansion bit with micrometer adjustment.

Two work-holding fixtures, Fig. 2, were provided so that the operator and his helpers may be mounting a motor shell on one of these fixtures during the time that the machine is working on the other. This fixture consists of a cast-iron drum which fits into the field-pole seats of the motor-shell giving it a firm support on these surfaces. The shell is clamped down with suitable bolts and the bearing brackets are supported by small jack-screws to prevent any tendency to rock during the boring operation.

When bearings have been badly worn they are built up with an acetylene torch or electric-welding apparatus before they are bored, enabling the reboring operation to be accomplished with the removal of a minimum amount of stock. It is standard practice to rebore the bearings $\frac{1}{2}$ in. larger in diameter than the original.

The motor shell with its holding fixture is placed on the table of the boring machine, as shown in Fig. 1, and lined up by suitable stops to insure the correct relative position with respect to the boring bars. A cutting speed of 42 ft. a minute is used with a feed of $\frac{1}{32}$ in.

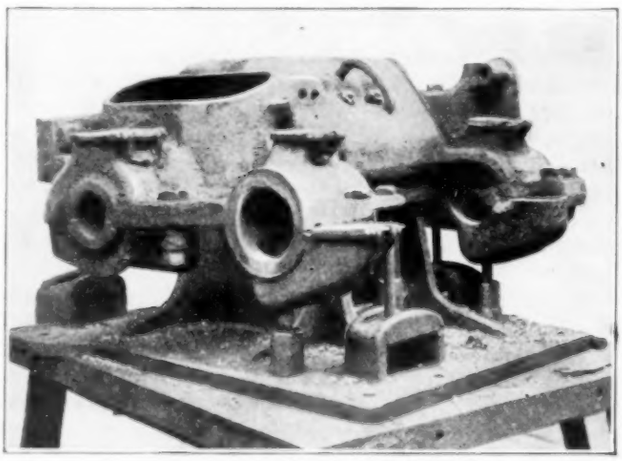


FIG. 2. HOLDING FIXTURE FOR SUPPORTING SHELL DURING REBORING

A Fatigue Testing Machine*

By F. M. FARMER

The apparatus described in this paper was developed at the electrical testing laboratories for the Research Sub-Committee of the Welding Committee of the Emergency Fleet Corporation. The purpose was to obtain information in regard to the relative durability of electrically welded joints in ½-in. ship plates when subjected to repeated reversed stresses. The principle employed is not new and has been used by other investigators for fatigue tests, but since the machine developed for this particular work is suitable for general fatigue testing and is so relatively simple and inexpensive, it is believed a description will be of interest and perhaps of value to others who may be interested in this particular phase of materials testing.

A SPECIMEN cut from a welded joint in a ship plate, Fig. 1, is not homogeneous but consists of two pieces of plate joined together with metal of decidedly different chemical, metallurgical and physical characteristics. Furthermore, the area of a cross-section through the deposited metal at right angles to the length of the specimen varies throughout the joint because of the V-shape of the deposited metal and the irregularity of the line of union between the deposited metal and the original metal. Therefore

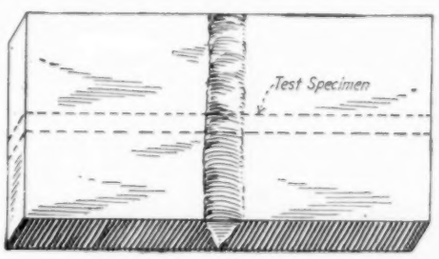


FIG. 1. SHOWING "V" WELD IN SHIP PLATE

it is essential that the apparatus be of a type which will produce a uniform stress throughout that part of the specimen in which the joint is located.

Another requirement was low cost. It is well known that if reasonably reliable data of this character are desired, a number of specimens of each sample must be tested. Since a large amount of research work was contemplated, this meant the development of a machine sufficiently simple and inexpensive to make it practicable to have a number available so that results could be obtained quickly.

Principles of Machine

The principle employed is that of a four-point rotating beam with two free supports at the ends and two loads at the middle. Fig. 2 shows the familiar shear and moment diagrams for a beam so loaded, in which $W_1 = W_2 = W_3 = W_4 = W$ and $x_1 = x_2 = x$. The moment between a and b is uniform and has the maximum value of Wx. If the beam has a uniform circular section, the maximum fiber stress in all sections between a and b is

$$S = \frac{Mc}{I} = \frac{Wx}{0.0982d^3}$$

in which

S = stress in outer fiber in pounds per square inch;
M = bending moment in inch-pounds;
c = distance from neutral axis to outer fiber, in inches, $= d/2$;
I = moment of inertia;
W = load in pounds;
x = distance between loads and supports, in inches;
d = diameter of beam in inches.

The beam is in tension on the lower side and in compression on the upper side. Thus if a circular rod

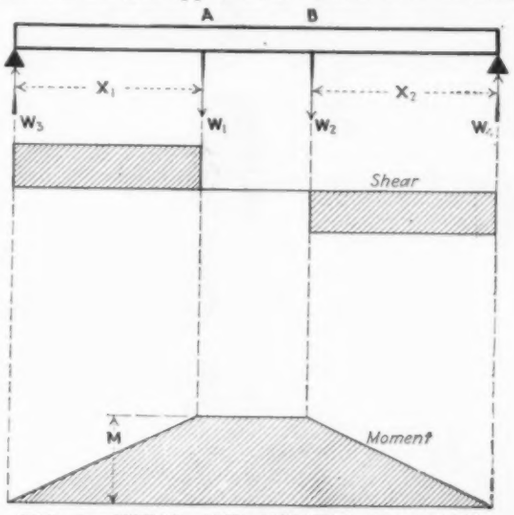


FIG. 2. SHEAR AND MOMENT DIAGRAMS

is turned from a specimen cut from a weld, loaded in the manner indicated above with the joint in the middle and then rotated, the joint will be subjected to a maximum stress equal to S alternately in tension and compression once per revolution.

Description of Machine

Fig. 3 is a photograph of the machine and Fig. 4 is a reproduction of a scale drawing. The specimen is carried by four self-aligning ball bearings, a, b, c and d. The two end ones rest in the pillow blocks, e and f, the whole being supported on a cast-iron base 5 x 19½ in. One of the pillow blocks provides for longitudinal movement of the bearing due to the slight bending of the specimen. The two equal loads are hung from hooks attached to collars which encircle the outer races of the two middle bearings.

The bearings are securely fastened at the proper position by means of two split collets of carburized steel with opposite tapers, one entering from each side of the bearing. This produces a wedge action which gives a uniform pressure over the entire bearing surface on the shaft and insures the validity of the assumption that the point of application of the loading

*Presented at annual meeting of the American Society for Testing Materials, Atlantic City, N. J., June 24-27, 1919.

forces is at the center of the bearings. The inner collet is counterbored as shown so that the bearing surface on the specimen is as short as possible. The collets are wedged together by a nut on a thread on the inner collet and are loosened with the aid of a wedge key driven under the head of the inner collet.

The specimen is rotated through the loose coupling at one end of the specimen and the revolutions are counted by a suitable counter geared to a worm on the other end of the specimen. These various fittings are most conveniently put in position on the specimen at a

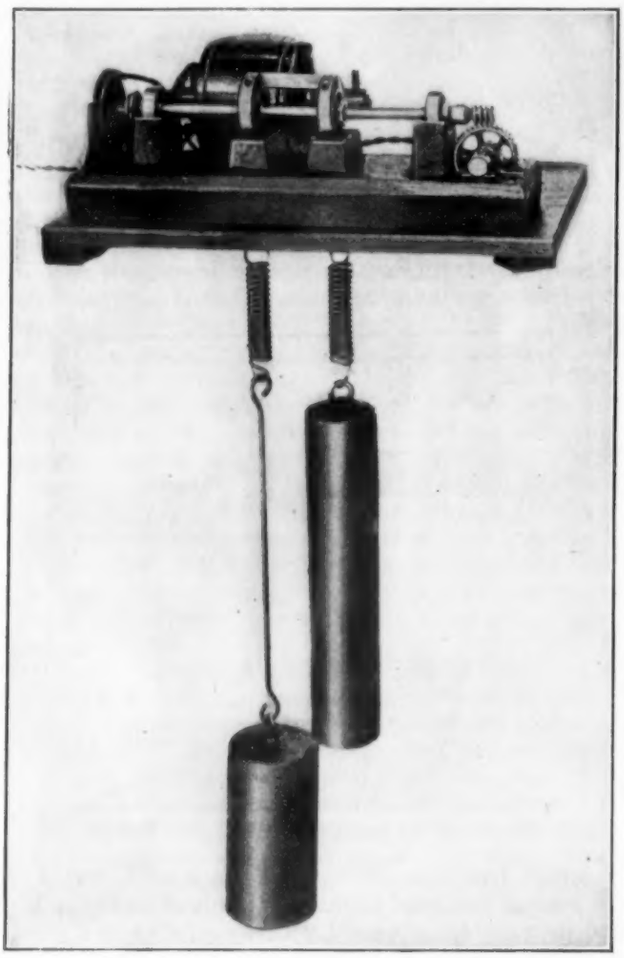


FIG. 3. FATIGUE TESTING MACHINE

vise on a bench. The specimen with the fittings in position is then dropped in positon in the machine, the weights hung on to the hooks (with spiral springs intervening) and it is ready to be rotated. The blocks *g* and *h* are merely for the purpose of preventing the weights dropping too far when the specimen fails.

When failure occurs, the specimen will stop rotating because it "binds" and the belt will either slip or be thrown off. However, the preferable way for securing automatic stopping is to provide a simple switch arrangement which will be operated by one of the weights when it drops. This will cut off the motor.

WELD SPECIMENS—This particular machine was designed for specimens from welds of ½-in. plates, but obviously a machine could be constructed for specimens of any ordinary diameter. It is planned to construct one with a longer base for specimens from ⅝-in. to 1-in. plate by providing bushings of suitable sizes and arranging for changing the distance between the supporting pillow blocks so that the weight can be kept within reasonable limits.

The standard specimen for the machine described is 13 in. long and 0.4 in. in diameter throughout its entire length. This diameter is about the maximum that can be turned out of ½-in. material which is rarely perfectly straight. Care is taken that the diameter in the middle portion is exact and that this part of the specimen is carefully finished free from tool marks or scratches.

ORIGINAL-METAL SPECIMENS—The criterion of the performance of a joint of any kind is the performance of a similar specimen of the original metal without a joint. Consequently fatigue tests of welds in ½-in. plate should be compared with tests made with the same apparatus and at the same stress on specimens from the original plate. When such tests were made with specimens of constant diameter throughout their length, failure always occurred at one of the load bearings and not between them, as is the case with weld specimens where the joint is (at least at the present stage of the electric fusion welding art) the weakest part of the specimen. It is believed that this is due to the sudden change in the stress distribution (see Fig. 2) at these points and probably also to the radial compressive stress induced at these points by the loads. By reducing the diameter between these points and using long fillets, failure will occur in the central portion of the specimen and the true endurance value of the metal will be obtained.

STANDARD STRESS ADOPTED

A standard maximum fiber stress of 25,000 lb. per square inch is being employed in the testing of weld specimens and the corresponding specimens of original metal. The selection of this value was based on the following considerations. The characteristic which it is desired to test is the elastic property under reversed stress conditions and not ductility, since in practice a material is never intentionally stressed above the elastic limit. This means, therefore, that the stress should be below the elastic limit because, as Prof. H. F. Moore† has pointed out, the relative performance of materials in a fatigue test will probably be very different above the elastic limit where the property involved is ductility, than it will be below the elastic limit where the elasticity is the property involved. On the other hand, the higher the stresses, the more quickly results will be obtained. As there is no reason to suppose that the *relative* behavior of different materials will not be the same at low stresses as at high stresses (provided they are below the elastic limit), a stress of 25,000 lb. was adopted. This is as close to the elastic limit of shipplate steel as it was thought advisable to go.

A considerable number of specimens of both welded joints and solid plate have been tested with the first machine built, and it has proved entirely satisfactory. The general order of the results so far obtained at 25,000 lb. per square inch maximum fiber stress is about 500,000 revolutions for specimens with welded joints and about ten million revolutions for specimens without joints, or a proportion of 1 to 20.

It is believed that the advantage which this principle has of making the stress uniform over a finite length of the specimen is an important one. Not only can the exact area at the point of maximum stress be accurately measured, and the stress accurately determined, but

†Professor Engineering Materials, University of Illinois

this principle can be utilized in a machine which is simple, compact and relatively inexpensive.

The objection may be raised that, so far as testing welded joints is concerned, the specimen is so small that it contains only a small portion of a joint and consequently in order to get reliable knowledge of a joint, a number of specimens along the joint must be tested. In other words, to get reliable fatigue results, the machine should be such that it would take a comparatively wide specimen. But the very fact that a small specimen requires a number of tests to be made is an advantage, because definite knowledge of the uniformity of the strength (or lack of it) along a long weld is very important, and obviously this would not be obtained with a wide sample. Furthermore, with the much greater speed permissible with a small machine and the larger number of machines which could be available, the equivalent in small specimens can be tested just as quickly as the one large specimen.

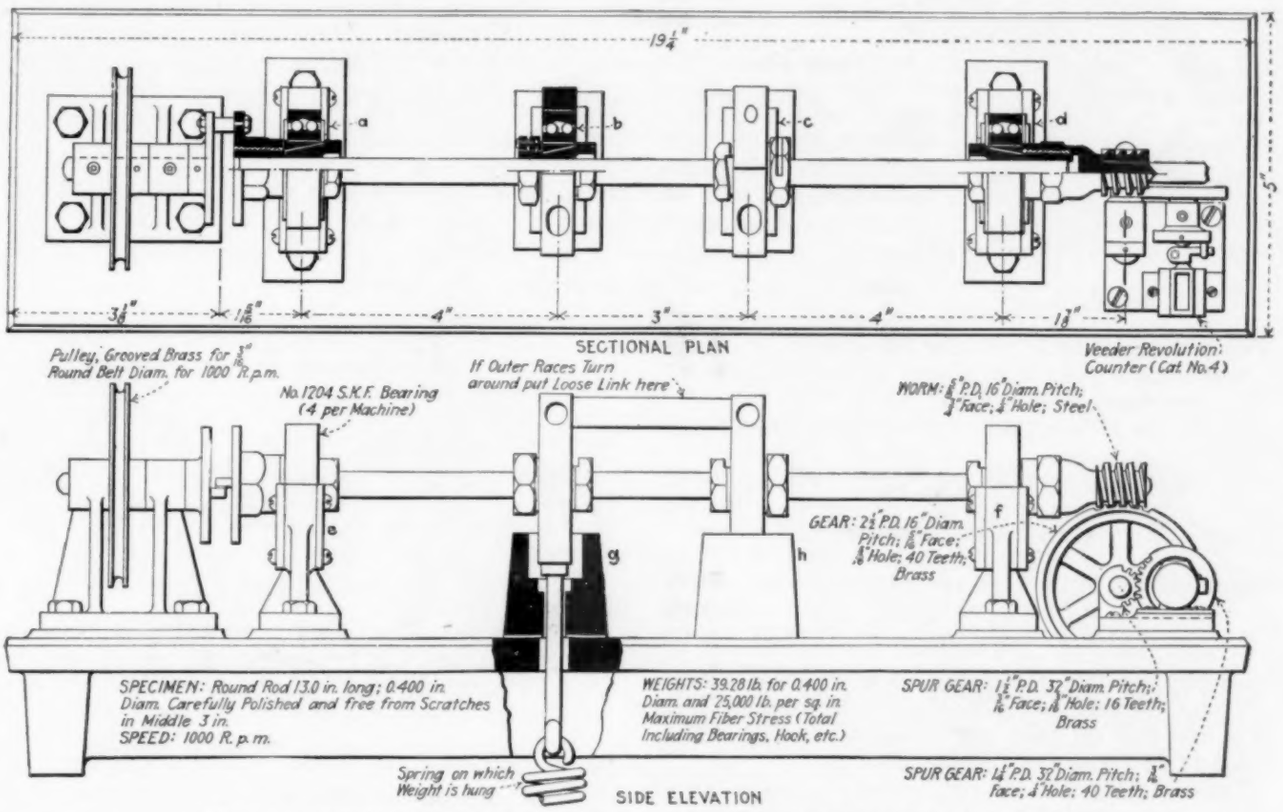

19¼"
a
b
c
d
3⅛"
1 5/16"
4"
3"
4"
1⅛"
SECTIONAL PLAN
Pulley, Grooved Brass for ⅜" Round Belt Diam. for 1000 ft. p.m.
No. 1204 S.K.F. Bearing (4 per Machine)
If Outer Races Turn around put Loose Link here
Veeder Revolution Counter (Cat. No. 4)
WORM: ⅝" P.D. 16 Diam. Pitch; ¾" Face; ¼" Hole; Steel
e
g
h
f
GEAR: 2½" P.D. 16" Diam. Pitch; ⅛" Face; ⅜" Hole; 40 Teeth; Brass
SPECIMEN: Round Rod 13.0 in. long; 0.400 in. Diam. Carefully Polished and free from Scratches in Middle 3 in. SPEED: 1000 R. p. m.
WEIGHTS: 39.28 lb. for 0.400 in. Diam. and 25,000 lb. per sq. in. Maximum Fiber Stress (Total Including Bearings, Hook, etc.)
SPUR GEAR: 1½" P.D. 32" Diam. Pitch; ⅛" Face; ⅜" Hole; 16 Teeth; Brass
Spring on which Weight is hung
SIDE ELEVATION
SPUR GEAR: 1¼" P.D. 32" Diam. Pitch; ⅛" Face; ¼" Hole; 40 Teeth; Brass

FIG. 4. REPRODUCTION OF SCALE DRAWING OF FATIGUE TESTING MACHINE

In closing, the author desires to acknowledge his obligations to Prof. H. L. Whittemore of the Bureau of Standards, who made many valuable suggestions in the course of the development of this apparatus.

Approximate Method for Determining the Strength of Gear Teeth

BY WILLARD A. THOMAS

Engineers who are concerned with the design of gears will no doubt be interested in the new application of an old formula for the determining of the strength of gear teeth. The following derivation is intended to present a direct method based upon the old reliable Lewis formula which can be easily carried in the memory, and which will prove very convenient in the absence of the usually necessary table of factors. The generally accepted formula covering the strength of cut spur-gear teeth is known as the Lewis formula and is usually written:

$$W = fbpy \qquad (1)$$

Where W = the safe load in pounds carried by the tooth;
f = the allowable unit stress for a given tooth velocity;
b = the width of the face of tooth, in inches;
p = the circular pitch, in inches;
y = a factor depending upon the form of the tooth and the number of teeth in the gear.

For 15-deg. involute teeth, which is nearly universal practice, the values of y will vary from 0.067 for a 12-tooth gear, to 0.124 for a rack, or infinite number of teeth.

The recommended values of f for cast iron are as follows:

v	f
100	8000
200	6000
300	4800
600	4000
900	3000
1200	2400

Where v is the tooth velocity in feet per minute.

In terms of horsepower, hp. $= \dfrac{Wv}{33{,}000}$

and the Lewis formula may be written:

$$\text{hp.} = \frac{vfbpy}{33{,}000} \qquad (2)$$

Then the width of the face of the tooth may be expressed:

$$b = \frac{33{,}000 \text{ hp.}}{vfpy} \tag{3}$$

The usual practice is to make b equal to $2\frac{1}{2}\,p$, with which case only we are hereafter concerned, so we can write:

$$2\tfrac{1}{2}\,p = \frac{33{,}000 \text{ hp.}}{vfpy} \tag{4}$$

replacing b with $2\frac{1}{2}\,p$.
This reduces to,

$$p = \frac{33{,}000 \text{ hp.}}{2.5\ vfpy} \tag{5}$$

$$p^2 = \frac{33{,}000 \text{ hp.}}{2.5\ vfy} \tag{6}$$

$$p = \sqrt{\frac{33{,}000 \text{ hp.}}{2.5\ vfy}} \tag{7}$$

The table of values of f and y still being necessary in order to make use of this last formula, we will try to eliminate the factors, f and y, and replace them with an expression that will at once be convenient and sufficiently accurate for general purposes. We will assume for the variable y an average constant value of 0.1. We can also show that f is a function of v, and can be expressed by the following relation:

$$\text{Approximately } f = \frac{600{,}000}{v} + 2000 \tag{8}$$

This is almost exactly true for either extreme value of v and always gives safe values at any point within the intermediate values of v.

Substituting these values for f and y in equation (7) we get,

$$p = \sqrt{\frac{33{,}000 \text{ hp.}}{2.5\ v\left(\frac{600.000}{v} + 2000\right)0.1}} \tag{9}$$

Which reduces to:

$$p = \sqrt{\frac{\text{hp.}}{0.015\ v + 4.5}} \tag{10}$$

This last equation (10) gives us a simple and fairly accurate formula for determining the circular pitch of a cast-iron cut spur gear whose face width will be equal to $2\frac{1}{2}$ times the circular pitch.

Equation (10) may be transformed for use in finding the safe transmitted horsepower into the following:

$$\text{hp.} = p^2\,(0.015v + 4.5) \tag{11}$$

Formulas (10) and (11) may be easily memorized for use where tables of values of f and y are not handy and will be found to be fairly reliable on account of the formulas being based on the more accurate Lewis formula.

It is worthy of note that cast-steel gears are twice as strong as cast-iron gears. For bevel gears, if p is measured at the middle of the face, then these formulas can be applied to cast-iron bevel gears, as well as to spur gears.

As an example of the use of formulas (10) and (11), consider a cast-iron cut spur gear having a tooth velocity v of 100 ft. per minute, a circular pitch p of 1 in., and the customary width of face, $2\frac{1}{2}\,p$ or in this case $2\frac{1}{2}$ in. By using the Lewis formula (2) we find the safe transmitted horsepower to be:

$$\text{hp.} = \frac{100 \times 8000 \times 2.5 \times 1 \times 0.1}{33{,}000} = 6.06$$

Or by the alternative method given in formula (11)

$$\text{hp.} = 1^2\,(0.015 \times 100 + 4.5) = 6.0$$

Or if we had been given the hp. to find the circular pitch by formula (10) we get:

$$p = \sqrt{\frac{6.0}{0.015 \times 100 + 4.5}} = 1.0$$

The above example was based on a value of 0.1 constant for y and is for approximate values only.

A Quickly Made Index Plate

BY M. L. LOWREY

Until recently I had always regarded the index plate of a milling machine as something rather difficult to make, but when compelled to get one out, in order to graduate a dial for a rush job, I made one so easily and quickly that I think a description of the method will be of interest to your readers. The job was to mark a dial with 250 divisions and the only machine available was a Cincinnati No. 2 universal milling machine which would not divide that number with the index plates that came with the machine.

As the job was in a hurry something had to be done immediately, and as it was a small job it would

A HURRY-UP JOB ON AN INDEX PLATE

not do to make an expensive rig. Therefore, ascertaining that a 25-hole circle would make the division, I found a casting of nearly the right size which I bored and faced at one setting, the back being left rough except the rear of the hub. This plate was then held in the universal chuck on the dividing head, an angle plate with a hardened bushing in it was bolted to the table with the bushing just touching the plate so that the drill could not run, and the indexing mechanism set to divide 25.

Then with a breast drill the hole was started and drilled in enough to spot it well, each hole being indexed and drilled in like manner. The plate was then taken to the sensitive drilling machine and the holes drilled through. The time of boring and turning was 45 min. and the indexing and drilling, 75 min. The hardened bushing was taken from stock, so that the total time on the job was about 2 hours.

I attempted to take a photograph of the set-up but the light was not good, therefore I secured the services of a friendly artist.

US ARMY ORDNANCE NEWS

Operations on the British 9.2-In. Gun—I

By I. WILLIAM CHUBB
European Editor *American Machinist*
Published by permission of the British Ministry of Munitions

The British 9.2 army gun is very similar in design and construction to the guns of the British navy. In this series of articles it will be noticed that both the construction of the gun and many of the operations in its production vary considerably from the practice on ordnance in the United States.

THE 9.2 in. gun body is built up of steel, with an A-tube into which is driven an inner A-tube, this being secured by a series of shoulders near the breech end and by a steel breech bushing which is screwed in place. The ends of the various layers of steel wire wound round the A-tube are fastened to seven steel rings, and over the wire is shrunk at the muzzle end a B-tube, while at the breech end a jacket is shrunk over the wire and a portion of the B-tube and secured by shoulder and by a threaded steel collar on the A-tube at the rear. Projections, with a key on the under surface of the jacket, form a seat for a band connecting the gun to its mount.

As to material the two A-tubes are of nickel-chrome steel, and the B-tube and jacket are of high-grade carbon steel.

This article is confined chiefly to a reasonably complete account of the machining operations on the gun body plus an account of the chief features in the building operations and some notes on inspection. No further details are available relating to the dimensions or construction of the gun.

In order that certain points in the machining may be appreciated, the rough-machined lengths and diameters are here given:

Inner A-tube, 37 ft. 10 in. long with maximum diameter of 17 in. and minimum diameter of 12¾ inches.

A-tube, 38 ft. 7 in. long, with maximum diameter of 24½ in. and minimum diameter of 15¼ inches.

B-tube, 19 ft. 7 in. long, with maximum diameter of 23¼ in. and minimum diameter of 20¾ inches.

Jacket, 25 ft. 6 in. long, with maximum diameter of 35½ in. and minimum diameter of 26 inches.

All the operations in the gun shop of the firm concerned, a large British organization devoted to ordnance, are done with standard tool shapes details of which are shown in Fig. 1. The range includes planing machine, slotting machine and turning tools, and the sheet also illustrates the tools used in the trepanning heads.

A fairly complete list showing the speeds and feeds employed in making these guns and, in fact, on guns ranging from the 4-in. to 14-in. size is given in table I. This hardly calls for explanation, but it may be stated that it was drawn up as the result of observation in the shops and forms the basis of practice. All rough-turning operations are dry, and the finish-boring in the outer A- and B-tubes and jacket are also dry operations, while lardoline diluted with water at 1 in 15 or so, according to cut, is applied at a pressure of 30 lb. in finish-boring the inner A-tube.

It will be seen that apart from the wiring the gun is built up of four main tubes. These are forged from blooms which, as they reach the machine shop, are of about the following dimensions:

Inner A-tube, 30 in. in diameter by 12 ft. long, with 9½-in. hole.

A-tube, 43 in. in diameter by 12 ft. to 13 ft. long, with 16½-in. hole.

B-tube, 40 in. in diameter by 7 ft. 9 in. long, with 16½-in. hole.

Jacket, 45 in. in diameter, by 15 ft. 6 in. long, with 22-in. hole.

While they vary in size these blooms before being forged go through essentially the same machining processes, according to the program given below. The processes are under the supervision of the heat-treatment department.

Operations on Blooms

Operation 1.—Cut Off to Length—One type of cutting off machine employed is illustrated in Fig. 2, which also shows how the bloom is held during the operation. By means of stools it is supported in adjustable V-blocks and gripped by link chain, as illustrated, the chain being tightened by a nut and screw at each end. In this operation it is usual only to square up the end of the bloom.

Operation 2.—Bloom Rough-Turned—Here the skin is removed to make sure that the material will finish satisfactorily. Any flaw that is discovered is milled or otherwise machined out clean, no visible flaws whatever being permitted in the rough-turned bloom. It is usual to take a cut from ¾ in. to 1 in. deep in order to get well below the slag, the lathes usually employing two carriages with four tools. The bloom is held in the lathe by a four-jaw chuck and supported at the other end by the tailstock center.

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Operation 3.—Hole Trepanned—One of the trepanning heads employed is illustrated in Fig. 3, the end of the head being bored taper to suit the bar, on which it is positioned by a corresponding taper and fixed by screws. Each cutting tool is secured by its shank in the trepanning head, but is driven by a slot in the face, a screw being used to retain it in position when withdrawing the head. There is a clearance between the head and the work of $\frac{1}{16}$ in. to $\frac{1}{8}$ in. so that the supply of coolant may reach the tool. The trepanning bar is fixed on the faceplate of the machine and positioned by a plug. The usual cutting speed is 28 ft. per minute with a feed of 0.015 in. per revolution. This process being completed the bloom goes to the forge shop and is forged to dimensions. The jacket bloom, for example, is pressed on a mandrel for the forging operation. The tubes are annealed and straightened and sent to the machine shop.

Operation 1.—Cut Off Surplus Stock at Ends—It is usual to allow about 7 in. on the length for cutting off the test disks.

Operation 2.—Lay Out Forging for Diameters and Bore—The purpose of this operation is to determine whether, after the forging operation, the tube will turn up to correct size. The tube resting on blocks, a plumb rule is put on each side and by this means a short center line is laid out and chalk-marked on top of the tube with the amount to be turned off shown on each side of the line. This is done the full length of the tube at about 4 ft. intervals, and then a string is

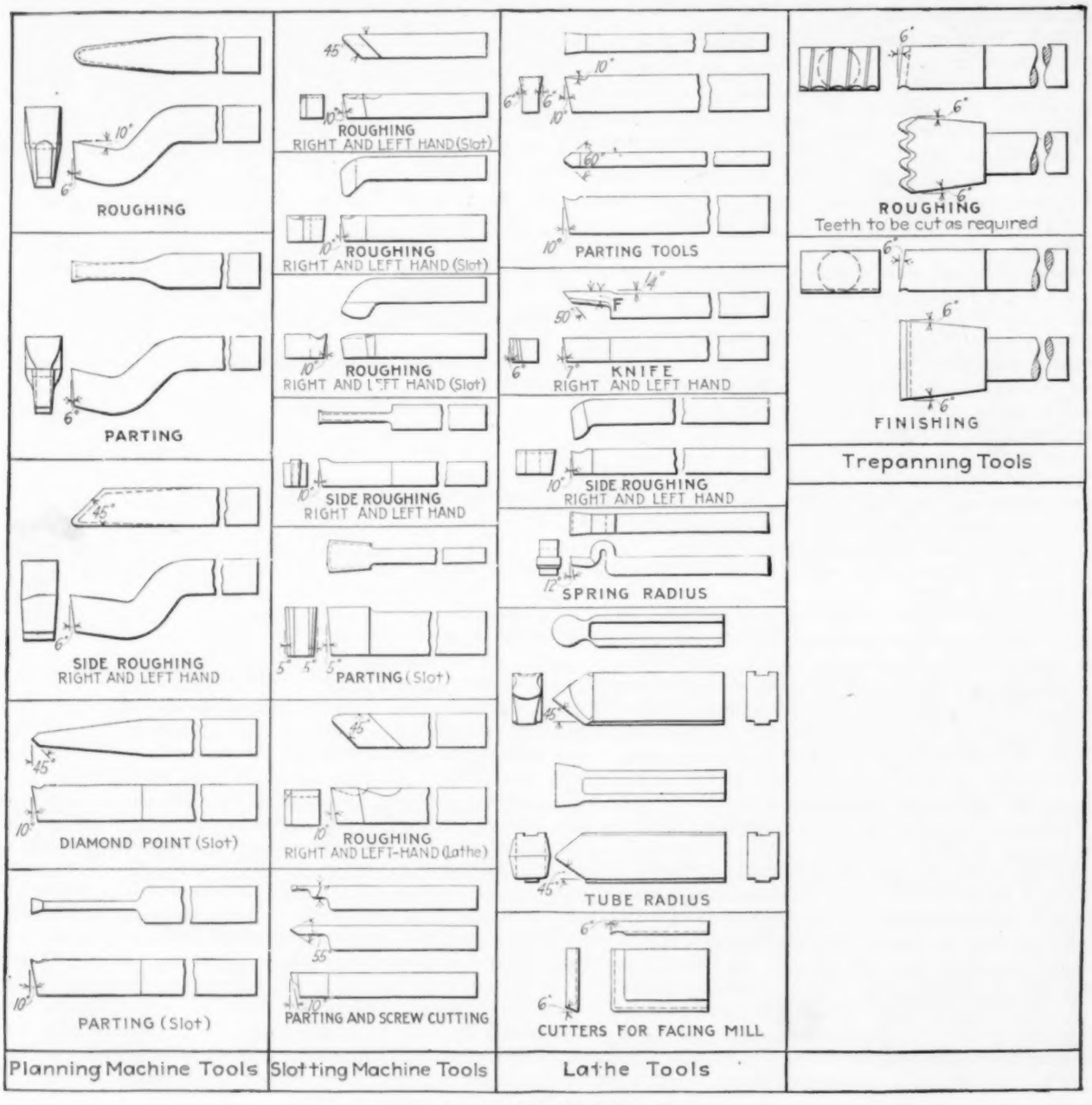

FIG. 1. STANDARD TOOL LIST

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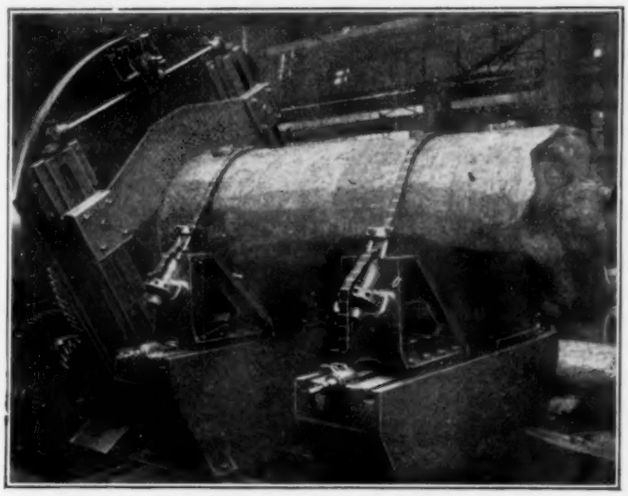

FIG. 2. CUTTING OFF BLOOM ENDS

stretched along the top, being set true to the center at each end. For the tube to clean up when turned the string must come between the two outer lines of the sets marked along the length. The forging is then turned through about 90 deg. and the same marking-off operation is undertaken. This process applies to each of the four tubes.

Dealing now with the jacket or any other tube with a relatively large central hole this is marked off on the outside as before, and then a wire is stretched through the center and the bore tested from this wire by means of a long rod with a T-head, one end of which is placed on the wire, while the other will show by how much, if any, the hole is large at the particular spot under test, a lamp at the other end of the tube enabling this to be seen.

Operation 3.—Rough-Turn and Prepare for Boring—This is of course a lathe operation, about $\frac{3}{4}$ in. being left on the diameter. To prepare for boring, steady rest bearings are turned at each end and in the center, each about 12 in. wide.

In all rough-turning operations on the tubes it is usual to drive one end by means of a four-jaw chuck, while the other is commonly supported by the tailstock center, a keyed plug shown in Fig. 4, being employed. The view shows a tube in the lathe being rough-turned. The keyed plug is of cast or forged steel, and consists of a flange with a projecting boss, the latter entering the tube. Around it a series of slots are machined for keys or wedges which secure the plug in the tube.

Operation 4.—Rough-Bore—The machine for this operation is double ended and of the type shown in Fig. 5. The tube is bored from the two ends simultaneously straight through, leaving about 0.8 in. on the diameter for finish. Usually the difference in centers where the bores meet does not exceed 0.10 in. If it should exceed this but not exceed $\frac{3}{8}$ in., the tube is placed in the lathe and set and turned so that the difference is halved. The rough-boring head carries two 1-in. square tools, which each take a cut about $\frac{3}{8}$ in. deep. It is usual in the same machine first to open out the hole for a length of about 12 in. by means of a boring tool.

Operation 5.—Examination—The inspection department undertakes this, checking diameters external and

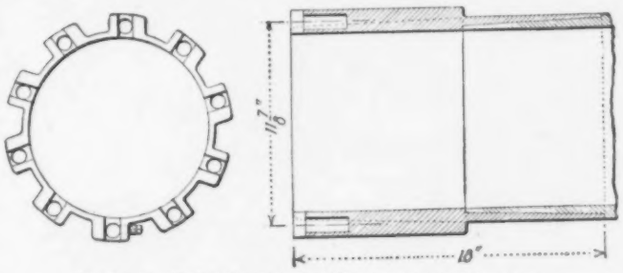

FIG. 3. DETAILS OF TREPANNING HEAD

internal and examining both exterior and interior in order to insure that no seam or other flaw goes forward.

Operation 6.—Heat Treatment.

Operation 7.—Saw Out Test Pieces—This is the work of a bandsaw, two opposite tangential cuts being taken for a depth of 1¼ in. down the tube at the bore and then cuts with a saw across the tube, resulting in the removal of two D-pieces.

Operation 8.—Cut Off Test Disks—The lathe is employed for this, as it will do the work quicker than a

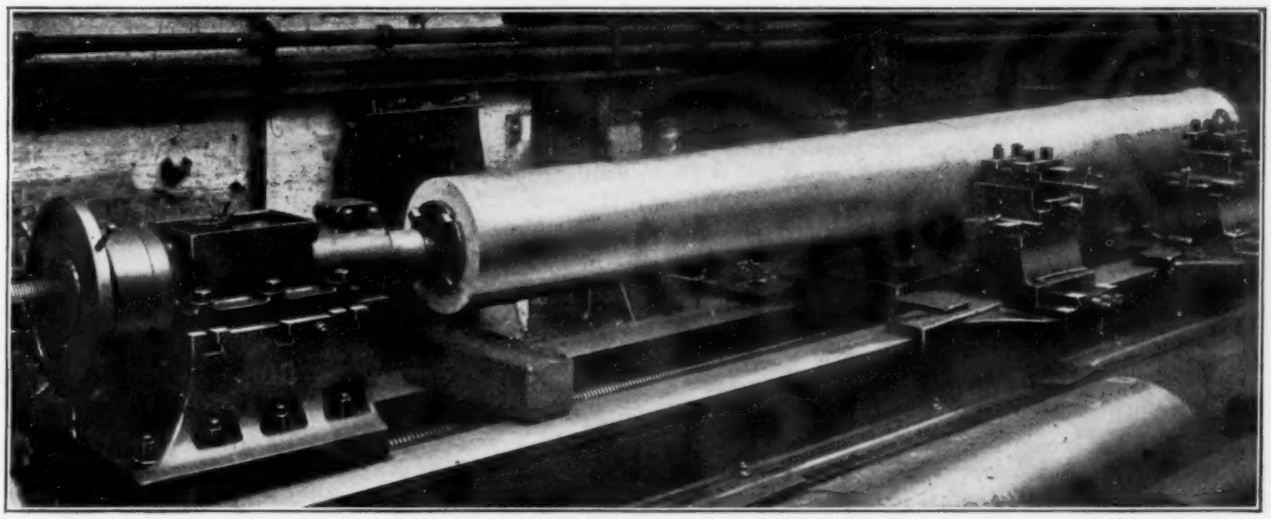

FIG. 4. ROUGH-TURNING THE A-TUBE

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saw and is more accurate than the cutting-off machine. A ring is taken from both the muzzle and the breech ends. The material then goes through the government tests.

Operation 9.—Rough-Turn and Prepare for Boring—Before this the tube is placed in the lathe in order to test it for straightness. It is kept rotating slowly and the high places in its exterior are shown by a surface gage, the amount by which the tube is out of truth being marked in chalk. It is tested at about every 8 ft. of length and if necessary sent to the forge shop to be straightened. If, when it returns to the machine shop it is say ¼ in. out, but not more, the ends are set over to compensate. In this operation the diameter is turned to within 0.4 in. The preparation for boring consists in smoothing up the bearings at each end and at the center and turning a spot 1 in. wide at each end true to the bearing, by which to line up the tube to the bed of the boring machine.

Operation 10.—Finish-Bore—For this three cuts are taken, the first to 9 in. diameter, the second to 9.15 in. diameter, and the third to 9.18 in. diameter. The first cut is divided by three tools, round nose at first and flat face at finish, the hole being opened out at either end, leaving about 0.03 in. on the diameter. With the second cut five boring tools are fixed in the steel head, and three lignum-vitæ strips are used to guide the bar, with two brass strips below to take the weight. On the bar also are two sets of brass strips as supports; they are 0.01 in. to 0.02 in. smaller than the bore. The reaming head is similar to the finish-reaming head detailed later and used after the gun is built. Inspectors examine and gage the interior.

Operation 11.—Test and Spot True to Bore—The tube is gripped at one end in the lathe chuck and the other end runs in a steadyrest. A gage of the rocking-bar type is placed in the tube with a disk fixed at the end almost the size of the bore to insure that there is no side play on the gage, and the straightness of the bore is thus determined. If the tube is found to be untrue it can be straightened by the application of weight. A bearing about 8 in. long is then turned true to the bore at the middle and a spot is turned at about the position of the chamber, also of course true to bore, and another spot about half-way between the muzzle and the center. The spots are about ¾ in. to 1 in. wide and are turned in order that the truth of bore may be tested in subsequent operations.

Operation 12.—Finish-Turn Outside Diameter—This is for the driving fit and the tube is turned to sizes given at every 6 in. length on a chart supplied by the inspection department, the diameters between these locating spots being subsequently blended.

Operation 13.—Thread Muzzle End—This is an ordinary screw-cutting job, the pitch being 2½ threads to the inch. The thread is for the insertion of driving and lifting plugs. In preparing for driving it is usual to leave 1 in. of stock on the breach end to take the blow of the ram. The inner A-tube is then ready for driving into the outer A-tube.

Operation 1.—Cut Surplus Stock Off Both Ends.

Operation 2.—Lay Out Forging for Diameters and

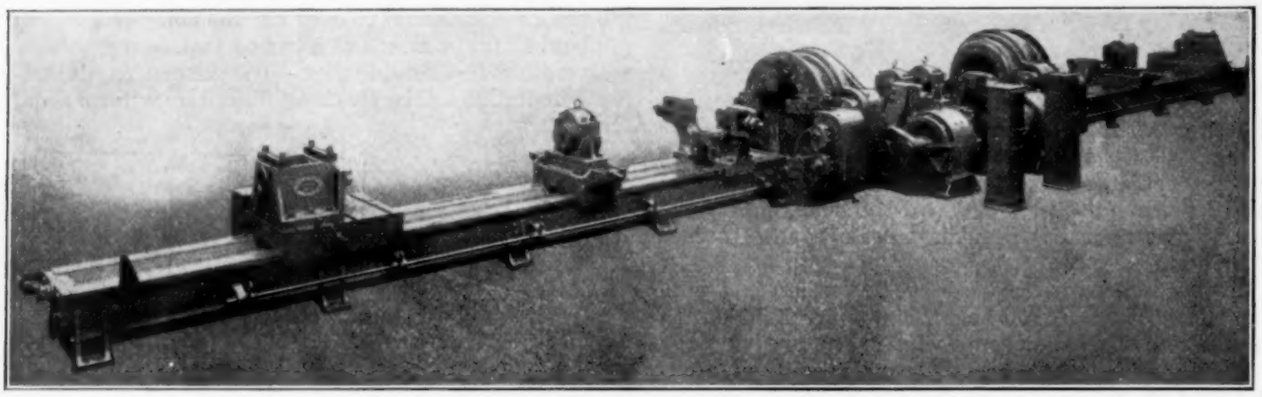

FIG. 5. DOUBLE-END BORING MACHINE

Bore—The remarks on this operation in connection with the inner A-tube apply here.

Operation 3.—Rough-Turn and Prepare for Boring—Each operation is to within about ¾ in. of finished diameter.

Operation 4.—Rough-Bore—This is a step-boring operation and is done by means of a slipper cutting head in the boring machine, three tools being employed, 1¾ in. by 1½ in. in section. The tube is bored from the muzzle end to given diameter, then for a given length from the breech end to a definite (larger) diameter, continuing for a further length to smaller diameter producing three steps. The head used is shown in Fig. 7 at *A* and the wood slippers at *B*.

Operation 5.—Examination—The inspectors examine to see that no seams, black parts, etc., show.

Operation 6.—Heat Treatment.

Operation 7.—Saw Out Test Pieces.

Operation 8.—Cut Off Test Pieces from Both Ends—These operations are as described previously. The tube material then has to pass the government tests.

Operation 9.—Rough-Turn and Prepare for Boring—The tube is tested for bend and straightened if necessary, as previously described, and is rough-turned, leaving 0.4 in. for finish, with 8 in. extra on the length of the largest diameter, so that in case of a mishap in the taper boring it will be possible to carry this up, the taper being 0.004 in. per inch length in the hole so that an 8-in. length gives 0.032 in. on the diameter.

Operation 10.—Rough-Bore and Prepare Bushing

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Seat—This is a step-boring operation and is done with slipper-cutting head. In the bore 0.20 in. is left on each diameter of the steps. To prepare for the taper cut, a straight seat 245 in. from the breech end is made for a bushing. The result of the operation is a series of steps largest at the breech end.

Operation 11.—Taper-Bore—A taper bar is used for this operation, a single-point tool being pushed along a groove which is inclined to suit the taper. The bore is straight at the breech end and is finished for a length of about 10 ft. 8 in. Then a bushing is fitted in at about 18 in. from the shoulder of the part finished and driven into position. Another bushing is placed on the bar about 24 in. from the front bushing, thus permitting work to be done with a bar at each end of the tube. The bushing is of cast iron 12 in. long, beveled for entry of the bar, with a plain bearing about 6 in. long; the rest clear. The muzzle end bushing is fixed in the tube, the breech-end bushing being on the bar so that it can be easily removed for gaging the bore. In this operation the tube is held in a four-jaw chuck at about the center of its length and the ends are run in steady-rests having rollers on top and pads below. After taper-boring the inspectors examine and gage the tube.

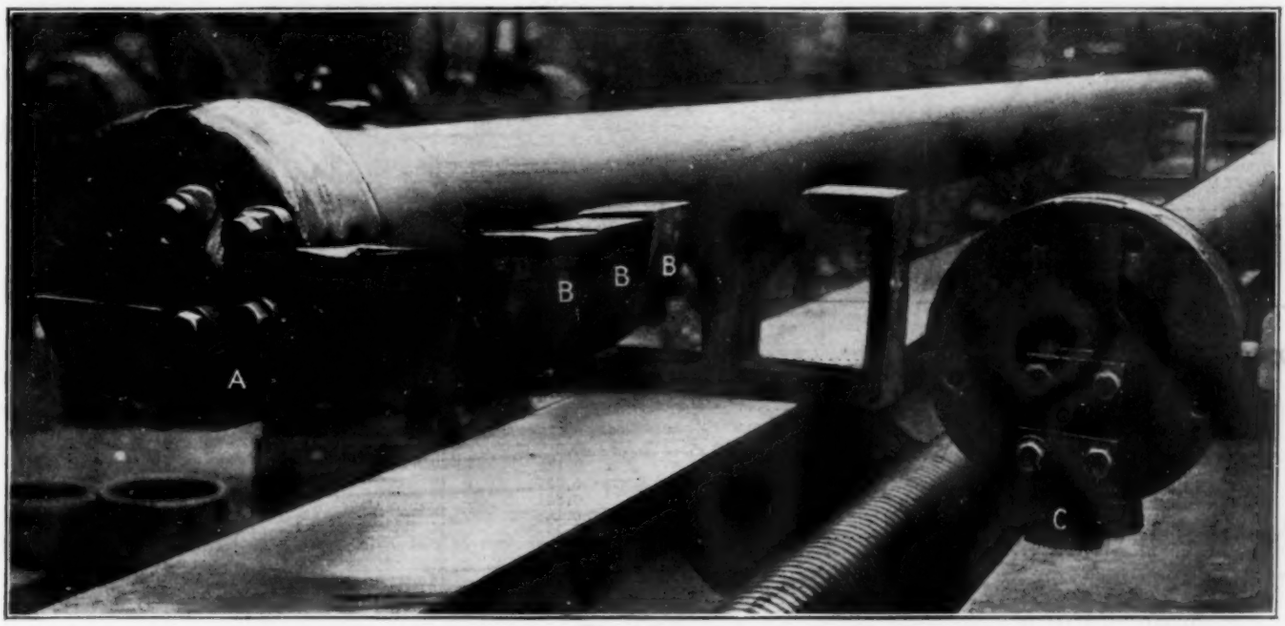

FIG. 7. ROUGH-BORING AND COMBING HEADS

The Comb-Bore

Operation 12.—Comb-Bore—Grooves all round the bore are combed in the tube by a special tool *C*, Fig. 7, the grooves being 200 in. long but missing the first 7 in. from the muzzle end. The work is indexed by means of the outside tooth of cutter; this is not important so long as the grooves do not overlap. Either the boring or the rifling machine is used. A collar is fastened on the end of the bar, and the comb tool is clamped by plates in a holder that has a slight swinging motion. Behind the tool, secured by screws, is a guide to the diameter to which the tool is adjusted. The comb is 2¼ in. wide and the pitch of its teeth is 0.15 in., the grooves produced being 0.05 in. wide by 0.01 in. deep. The comb tool cuts simply by weight, the hole being taper.

Operation 13.—Scrape Grooved Section—This is a hand operation to remove the burs raised in the combing process. The scraper is ¾ in. thick and about 7½ in. wide by 4 in. deep, curved to the bore; it is fastened at the end of a long wooden bar. The job takes about 12 hours.

Operation 14.—Cut Off End to Length—A lathe is used for this in order to get a square face for driving, the cut being made at the muzzle end where about 3 in. is left on the length. The tube is then ready to receive the inner A-tube.

Machining B-Tube

Operation 1.—Cut Surplus Stock Off Ends—This is done to rough lengths.

Operation 2.—Lay Out Forging for Diameters in Bore.

Operation 3.—Rough-Turn and Prepare for Boring—In the lathe a bearing about 10 to 12 in. wide is turned at about 18 in. from each end for a steadyrest and the tube otherwise rough-turned. The bearings are of no particular diameter but simply turned true. A spot 0.10 in. wide is also turned about 5 ft. from the breech-end shoulder for setting the tube true in the boring machine. As to the setting of the job in the lathe there is no trouble about concentricity, as it is usual to have about 2 in. in the bore to be removed.

Operation 4.—Rough-Bore—This is a step cut, an 8-in. diameter bar being used with usually three collars, each carrying tools set to the diameter.

Operation 5.—Examine.

Operation 6.—Heat Treatment.

Operation 7.—Saw Out Test Pieces.

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Operation 8.—Cut Off Test Disks at the Ends—These operations call for no comment.

Operation 9.—Rough-Turn and Prepare for Finish Boring—This is essentially the same as in the outer A-tube, the B-tube being turned to within 0.40 in. of finished size, leaving 8 in. of stock on the length for use in the event of the boring being too large when finishing for wire: the taper can then be carried up. No support is needed in the lathe, the tube being relatively short.

Operation 10.—Rough-Bore—For this a threaded bar is used with single-point tool, the bar being set over to suit the taper.

Operation 7.—Saw Out Test Pieces.

Operation 8.—Cut Off Test Pieces from Both Ends—Nothing need be added to what has previously been said on similar operations.

Operation 9.—Rough-Turn and Prepare for Boring—The jacket is held in a chuck and by key center at the other end, no steadyrest being necessary, as the tube is stiff. A bearing 14 in. wide is turned, 16 in. from each end, and also a spot for truing the job in the machine, the spot being about 1½ in. wide and in any position convenient to the central chuck of the boring machine. The jacket is turned to within 0.40 in. of finished diameter, the usual allowance when preparing for boring.

TABLE I. TURNING SPEEDS AND FEEDS

Description	Operation	4-in. Guns		6-in. Guns		9-in. to 14-in. Guns	
		Speed, Ft.	Feed, In.	Speed, Ft.	Feed, In.	Speed, Ft.	Feed, In.
Inner tube, forging	Rough-turn	30	0.125	30	0.125	20	0.2
Inner tube, forging	Rough-bore	25	0.008	25	0.008	20	0.03 to 0.06
Inner tube, hardened	Rough-turn	18	0.125	20	0.125	20	0.15 to 0.18
Inner tube, hardened	Rough-bore	18	0.015	18	0.015	15	0.03 to 0.06
Inner tube, hardened	Draw boring	14	0.05 to 0.1	14	0.06 to 0.125	10	0.18
Inner tube, hardened	Semifinish-turn	12	0.1	12	0.1	..	....
Inner tube, hardened	Finish-turn	9	0.375	9	0.375	13	0.2 to 0.25
A-tube, forging	Rough-turn	30	0.15	30	0.15	20	0.2 to 0.25
A-tube, forging	Rough-bore	31½	0.011	31½	0.011	29	0.03
A-tube, hardened	Rough-turn	18	0.125	24	0.125	20	0.15 to 0.2
A-tube, hardened	Rough-bore	18	0.015	18	0.015	18	0.07 to 0.1
A-tube, hardened	Finish-bore	8½	0.07	8	0.1	10	0.2 to 0.3
B-tubes, forging	Rough-turn	30	0.15	30	0.15	25	0.25
B-tubes, forging	Rough-bore	30	0.01	20	0.03	22½	0.03
B-tubes, hardened	Rough-trun	20	0.125	20	0.15	15	0.2 to 0.25
B-tubes, hardened	Rough-bore	20	0.03	20	0.03	20	0.1
B-tubes, hardened	Finish-bore	18	0.04	12	0.1	10	0.25 to 0.3
Jacket, forging	Rough-turn	30	0.125	30	0.125	20	0.25
Jacket, forging	Rough-bore	25	0.015	18	0.05	25	0.03 to 0.06
Jacket, hardened	Rough-turn	20	0.125	20	0.125	15	0.2 to 0.25
Jacket, hardened	Rough-bore	24	0.025	18	0.062	20	0.05
Jacket, hardened	Finish-bore	18	0.06	14	0.15	10	0.2 to 0.3
Wire or tube seatings	Rough-turn	18	0.1	18	0.125	20	0.16
Wire or tube seatings	Finish-turn	16	0.25	16	0.25	18	0.25
Turning wire	Finish-turn	9	0.2	9	0.2	10	0.25
Exterior	Rough-turn	31	0.08	31½	0.08	20	0.2
Exterior	Finish-turn	12	0.125	14	0.125	10	0.2
Exterior	Spring-tool	9	0.375	9	0.375	13½	0.625
Bore	Rose-bitting	4½	0.125	6	0.125	6	0.18
Bore	Rifling	..	.....	..	.....	22	.....
Seating for breech ring	Rough-turn	20	0.1	20	0.1	18	0.18
Seating for breech ring	Finish-turn	18	0.1	18	0.1	16	0.2
Breech bushing	Turn	25	0.125	25	0.125	25	0.125
Breech bushing	Rough-bore	40	0.06	40	0.06	40	0.06
Breech bushing	Finish-bore	12	0.1	12	0.1	12	0.1

Operation 11.—Finish-Bore—A short parallel portion at the breech end is bored with the bar set central with the machine, and the short step, also parallel at the muzzle end, is produced in the same way. In connection with this operation great care is essential when tightening up the chuck jaws as the tube is very thin and undue pressure would cause it to be out of round when released from the machine.

After this operation the bore is examined and gaged.

The Machining Operations on The Jacket

Operation 1.—Cut Off Ends to Rough Lengths.

Operation 2.—Lay Out Forging for Diameters and Bore.

Operation 3.—Rough-Turn and Prepare for Boring—These processes are as before, 8 in. being left on the length before building.

Operation 4.—Rough-Bore—This is a step boring operation and is done with threaded bar. The jacket is held in the center of its length and bored right through. At the ends it rests in pads. The result is a series of three steps and a taper length.

Operation 5.—Examination.

Operation 6.—Heat Treatment.

Operation 10.—Rough-Bore—This is done in the same way as operation 4 to within 0.20 in. of finished size.

Operation 11.—Finish-Bore—This is a similar operation, a smooth, dry cut being taken. It is usual to make allowance equal to the length of the frame seating plus the ½ in. length on the A-tube so that the jacket will come flush with the face of the A-tube. It is then possible to check the building length more accurately. Inspectors examine and gage the bore.

Operation 12.—Bore and Thread Breech End—The work is done in a lathe, the jacket being held at the muzzle end by a chuck and supported at the breech end by a steadyrest. Ordinary boring and screw-cutting tools are employed. The breech end is threaded for a collar, the thread being cut to within 0.020 in. of size so that after the building operation a final cut can be taken on the screw to suit the collar. It should be explained that at the breech end of the gun are two collars, one a collar shrunk on the end of the inner A-tube immediately over the breech bushing, the other a threaded collar placed outside the shrunk collar against a shoulder, on which it bears, and threaded into the end of the jacket. The operation being completed the jacket is ready for building on the gun.

Efficiency of Both Sexes in the Machine Industry

By L. W. ALWYN-SCHMIDT

The adjustment of labor for after-war conditions presents problems for immediate and serious consideration. During the war it was a question of obtaining help regardless of the training or fitness of the available labor for the work at hand. However, with the necessity of reëmploying returned enlisted men, whether women will be able to compete with men in various industries on a "dollar and cents" basis depends upon their comparative efficiencies.

DURING the war, women replaced men in many activities which in pre-war times were held to be exclusively within the domain of male labor. With the conclusion of the war, the question of female labor looms large as one of the problems of economic reconstruction. The result so far has been a more general discussion about the comparative productive value of male and female labor, and during the last few months much authoritative information on the subject has reached the public. From all the mass of material now offered for the contemplation of the factory and machine-shop manager so far the following seems to stand out:

(1) Female labor was introduced during the war into fields of industrial production where it did not exist before the war because no male labor could be obtained.

(2) There existed an emergency which did not permit any other choice.

(3) With the war at an end and a much larger number of men available for industrial service, female labor must take its chance on the sole count of comparative efficiency.

(4) The problem of female labor must not be approached alone from the point of view of providing labor for industrial production but also from that of national expediency.

Replacement of Men by Women

The ratio of replacement of men by women has been of varying strength according to the character of the industry. Women, according to a report by the State of New York, Department of Labor, have replaced men: where the material to be handled was not too heavy or could be lifted by a boy or a man serving several workers; where the machine could be operated without undue physical strain on the part of the operator; where the machine could be reset and cleaned or adjustments made by a woman or by a man serving several women; where training could be reduced to a minimum by the production of a standardized product or the subdivision of a process.

There is still little known about the actual effectiveness of female labor in the machine industry. A research made some time ago by the National Industrial Conference Board, however, throws some light on this very important question. A summary of the replies to questionnaires sent out to 254 plants during this research shows that 16 per cent. of these plants find that the output of women was greater in all operations than that of men; in 6 per cent. it was greater in some operations and equal in others; in 30 plants it was equal in all operations; in 6 per cent. equal in some operations and less in others, and in 7 per cent. less in all operations. Thirty-five per cent. of the questionnaires were not answered.

Several Viewpoints

That women are peculiarly adapted to certain machine-shop work is borne out by several expressions of shop managers which are quoted from the report of the New York Department of Labor. One letter says that "women have done very well on the operation of light machines but have less mechanical ability than men and require far more supervision and assistance. We believe that in time a number of women might be trained to sufficient mechanical ability to do as well as men. On machine operating or specialized woodworking jobs, assembling or inspecting or other mechanical operations, I believe that women are thoroughly qualified to handle the work and to my mind can see no reason why they will not be retained in the after-war period." An English engineer says of the ability of women to do heavy lifting that "women can safely handle in the course of machining and fitting operations pieces weighing up to 60 lb. and can also manipulate almost as well as men, with the aid of lifting appliances, any weights over 80 lb. It is on weights weighing between 60 and 80 lb. where it becomes questionable whether women can be properly and economically employed. There is the cost of special lifting tackle and handling devices necessary for women that may be obviated in the case of men, and in instances where tackle has been provided for dealing with these weights, it has been found that women prefer not to go to the trouble of using such tackle and so overtax their strength by endeavoring to lift weights which after a time generally results in injury to health."

On the contrary, one manager expresses himself to the effect that "we employ from 7 to 10 girls in our plant all the time. Most of them, however, proved unsatisfactory and cost us more by one-third than what we could have hired men for, but we used them during the time when men were not procurable."

Women More Punctual than Men

An interesting comparison, taken from a report of an investigation made in Cleveland, as to the relative attendance and ease of management of men and women shows that women are more punctual than men and furthermore that the transference of women from one machine, operation or department to another is a comparatively easy matter. This report also points out, in this respect, that "opinions favorable to women are expressed by the managers of the industries in which women are newcomers. A possible explanation of this may be that the women in these newer industries were more carefully selected and that most of the managers had provided some form of shop training so that the women might learn the best and quickest way at the outset."

No doubt, the efficiency of female labor is closely related to the problem of providing suitable training for

women in trades which may finally be restricted to women. Training women during the war was greatly hampered by the necessity of bringing the women as quickly as possible to a standard where they could perform the particular work for which they had been engaged. Training in most cases, therefore, has not been varied enough to produce all-round efficient machine-shop workers.

Under these circumstances the training method employed by the Bethlehem Steel Co., which is described in a publication by the Federal Board of Education, deserves special attention. "The new workers are taught to operate any of the following types of machines: drill presses, gun-boring lathes, turret lathes, planers, shapers, milling machines and to do bench work. As soon as they develop ability in the training school to handle themselves with a certain degree of skill they are placed in the production shops at the kind of work for which they were trained. Supervision over them is exercised in the production shops until they complete training. All women learners are given the rate of 25c. per hour while in training. The nature of the work in the machine shops makes it necessary to train women to be general machine operators or bench hands, that is, they must be taught a rather wide scope of work including blueprint reading and use of precision-measuring instruments. In general the women are given a broad training and not a training on specialized operatio[illegible]

In estimating the industrial effectiveness of the work of women as compared with that of men, the question of comparative cost is of considerable importance. The actual wage scale can give only a very imperfect answer to that question.

Wages Paid in a Government Plant in New York State

In a Government plant operating in the State of New York, the following regular daily wages were paid: Milling: men $3.04, women $2.56; drilling: men $3.60, women, $2.56; edge grinding: men $2.24; women $2.24; inspecting: men $4.00, women $2.24; centering: men $3.54, women $2.56; glass grinding: men $3.60, women $2.24; automatic polishing: men $3.60, women $2.24; assembling: men $3.20, women $2.24.

The New York report remarks that "an effort to relate womens' wages to their industrial efficiency is disappointing. Logically, it would seem safe to assume from an isolated statement of wage rates, such as the foregoing, that women were receiving less than men for the same work for one of two reasons: First, because, though possible expedients in an emergency, they were impossible substitutes when men could again be secured; second, that, although satisfactory at the rate of wages paid, they would be an economic loss at that higher male rate. Both alternatives hang upon the relative production of men and women workers."

The report then gives a rather interesting comparison of the relative production of male and female labor. In one plant the women operators assembled only 2 per cent. more tools than the men during a period of 21 days, while on punch presses women produced an average of 50 per cent. more pieces per hour than men. In another plant the comparative efficiency of men and women on certain machines was found to be: Milling machines: men 93.5 per cent., women 97.1 per cent.; broaching machines: men 95.5 per cent., women 95.5 per cent.; punch presses: men 97.5 per cent., women 92.3 per cent.

It can be readily seen, therefore, from the foregoing comparisons, which are typical averages, that there is considerable variation in the productive values of male and female labor. This affects the wage rates to the extent that attempts to show direct relations between male and female production rates and corresponding adequate wage rates have proven futile.

In order to equalize these conditions and to establish standards for employment purposes the following principles should be followed:

(1) Women should under no circumstances be employed at lower rates than men in the same class of work.

(2) Women in the capacity of mothers must enjoy certain measures of national protection which in certain instances may even go as far as to exclude them completely from designated employments.

Adherence to the first rule will soon bring about a certain selection in the character of employment offered to women in the machine-building industry. Women will take their places on such operations where they will be able to compete with men at similar wages. The second rule will exclude women from many operations for which, by reason of natural impediments, they are not fit. Female labor in this respect must take the same position as child labor today and experience will soon show those fields of employment for which women are best suited. The experiences of the war should not be used as a basis, as the exceptional conditions existing during that time have made necessary more latitude in the taking of personal and national risks than will be permissible in normal times.

The Future

The increasing employment of women in the machine-building industries, however, must have one very decisive effect on conditions in that industry which cannot be foreseen by legislation: namely, a likely change in the character of factory equipment. The use of well-trained female labor may induce our engineers to devise machinery permitting the employment of women in many operations from which they are now excluded owing to reasons of national expediency. The war has already produced machine tools designed for the special purpose of executing special operations and this development will no doubt continue. Any national policy evolved, therefore, to regulate the employment of female labor in machine shops, should be of a character to encourage such employment rather than to limit it.

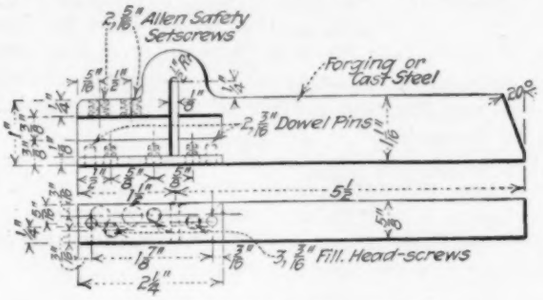
Our whole knowledge of the psychology of employment is still in its infancy. It is especially backward in that important part which directs the selection of the right man for the right job. There will, no doubt, be an enormous influx of women labor into the industries of Europe. With labor leaving our shores at unprecedented rates and little expectation for an early return of immigration, we shall soon be compelled to reorganize our own industrial scheme and a new labor emergency will be created similar to that of the war which most likely will establish female labor firmly in all American industries. We cannot therefore, afford to let run to waste so effective a source of labor as that offered by women. The earlier we make them part of the permanent labor force of the American machinery industry the better for ourselves.

A Convertible Toolholder

ROBERT M. HAYES

The illustration shows a toolholder which I designed a short time ago. It has the advantages of being cheaply made and giving complete satisfaction.

Many shops have so little use for a spring toolholder that it is not considered advisable to purchase them.



A CONVERTIBLE TOOLHOLDER

The purpose of this design is to furnish a toolholder for everyday straight lathe work that can be converted into a spring holder when necessary by simply removing the ¼-in. plate which is fastened on the bottom with three fillister-head screws and two dowel pins.

It is not even necessary to use a broaching tool in making this holder, as the two safety screws will furnish ample strength to hold the tool in the slot that is milled in the side.

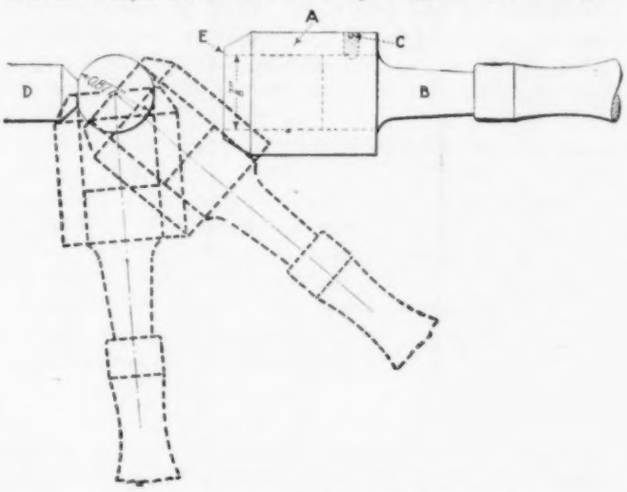
Forming an Accurate Ball on the End of a Rod

BY J. HAMILTON

Mr. Soule's method of making a ball on the milling machine shown on page 1141, Vol. 50, is all right so far as it goes, but if he wishes to make more than one ball of the same size, he will have to be very careful in the setting of the crossfeed. The rotary feed of the work must be very slow or the resultant ball will be anything but smooth. If he wants to make several balls and have them the same size *exactly* and dead smooth, he can obtain these results in the following manner:

Let him rough out the balls in the manner he has shown but have them, say, 0.002 in. oversize; this can be easily accomplished by manipulating the cross-slide.

Then let him make a tool, as shown in the illustration herewith. The tubular part *A* is tool steel hardened and ground out ¾ in. in the hole. The handle *B* is held in *A* by the grubscrew *C*. The work *D* is, after roughing out in the milling machine, gripped in the chuck of a speed lathe. With plenty of oil applied to the work, the tool *A* is pressed against the rotating ball and moved back and forth as shown by the arrows. The face *E* is about $\frac{1}{16}$ in. wide and ground at a right angle with the bore. The cutting edge is therefore square and gives a fine scraping cut. The advantage of this tool is that it does its own calipering, as the ball goes



HAND SCRAPING TOOL FOR FINISHING ACCURATE BALLS

inside the tool and cutting ceases as soon as the ball is scraped to the size of the hole in the tool. The tool is sharpened by grinding face *E* square with the hole.

Calculations for a Tangent Formed Cutter

BY A. R. MELLOY

For certain kinds of work a formed cutter, as shown in the illustration, may be used. This cutter is fed directly into the work on a center line and does not move back and forth past the tangent point as an underslung cutter does. The calculations are much simpler than those for the underslung type.

In the layout of the cutter and job, as shown, it is necessary to obtain the heights *BK* and *CL* which are perpendicular to the face *AA* and measured from it. To get these values we must first solve the oblique triangles *AOB* and *AOC* corresponding to the steps in the cutter to obtain the sides *AB* and *AC*. We can then solve the right triangles *ABK* and *ACL* in order to obtain the sides *BK* and *CL*. A definite top rake *D* and front rake *E* must be established and maintained to secure uniformity of results.

Referring to the figure; with angle D established, angle $OAB = 180$ deg. $- D$, and AO and OB are given radii of the work. In triangle AOB we can then establish the ratio: $\frac{OB}{\sin OAB} = \frac{AO}{\sin ABO}$, from which the angle ABO can be determined. The remaining angle of the triangle $AOB = 180$ deg. $- (OAB + ABO)$ and $\frac{AB}{\sin AOB} = \frac{OB}{\sin OAB}$, from which we can get AB.

Turning now to the right triangle ABK, the angle $BAK = 90$ deg. $- (D + E)$, and the hypothenuse,

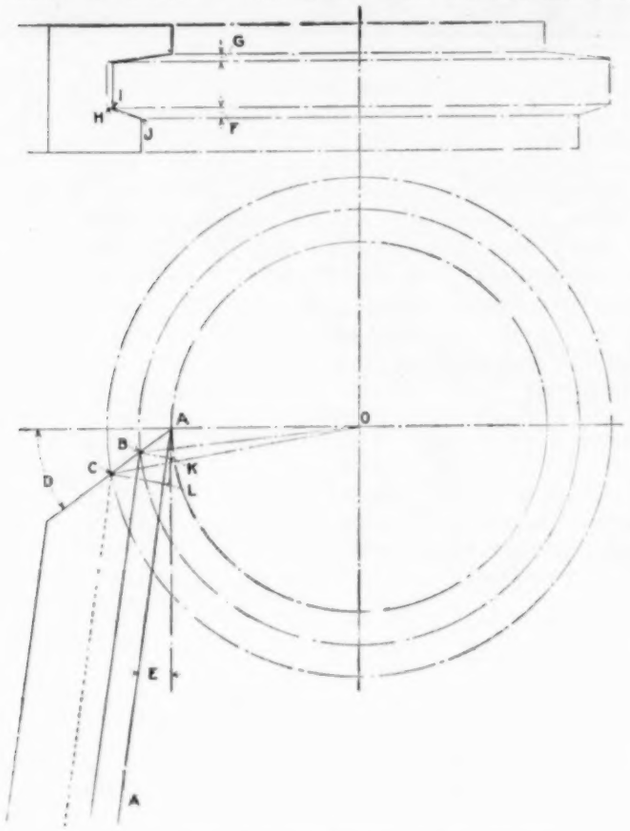


DIAGRAM FOR CALCULATIONS OF TANGENT FORMED CUTTER

AB has been found. Then the side we are after, $BK = AB \sin BAK$.

CL is found by similar treatment of the triangles AOC and ACL.

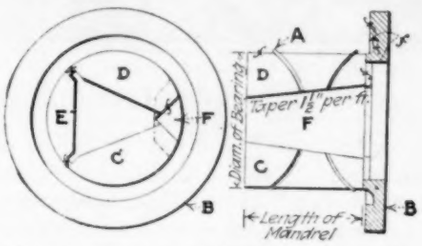
It will be noticed in the plan view that the angle of the cutter differs from that of the finished job as indicated by the triangle HIJ. These angles will take care of themselves, however, if the widths F and G are established and the depths calculated as described.

Collapsible Babbitting Mandrel

By M. H. Ball

The collapsible babbitting mandrel shown in the accompanying illustration was designed for rolling-mill pinion-bearing boxes and has proven satisfactory for bearings from 4 to 14 in. in diameter. Its advantages increase as the diameters of the bearings increase.

With the exception of the oil-groove rings A, which are made of machinery steel, the mandrel is cast iron. The baseplate B is grooved to form the babbitt flange and radius corner required on the face of the bearing and is bored to receive and locate the three sections C, D and E, and the taper-locking section F, which form the cylindrical part of the bearing. The mandrel, when ready for use, should be about $\frac{1}{8}$ in. longer than the bearing box in order to assure a clean bore after pouring the bearing metal. The half-round strips A, which form the oil grooves, are pinned to the sections in such a way as to make one continuous groove. The oil-groove rings are omitted from section F for the reason that an oil pocket is cast in the bearing box at this point which should be the full width of the section.



COLLAPSIBLE BABBITTING MANDREL

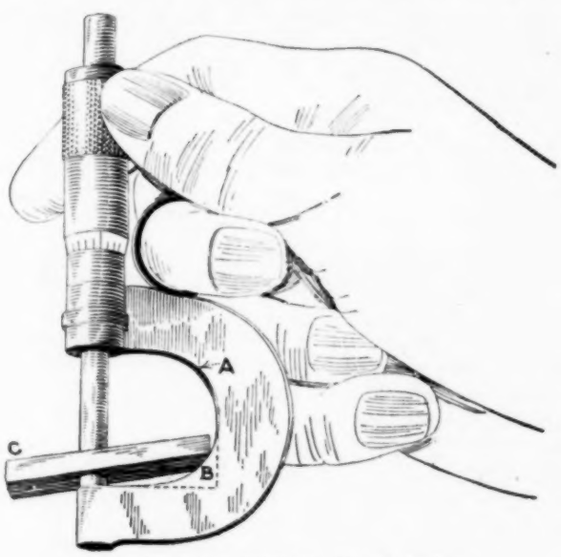
In designing a mandrel of this type the locking section should be located on the underside of the bearing and of a size that, when withdrawn from the mandrel, will permit the other sections to collapse radially in such a way that the surface of the bearing metal will not be marred.

A good way to machine the sections C, D, E and F is to plane the flat surfaces first; then assemble them and fasten a disk to each end with capscrews; after which the centers are drilled and countersunk in the disk, and the complete mandrel turned.

A Suggestion to Makers of Micrometers

By M. E. Duggan

Micrometer calipers are made with a C, or half-circle frame as shown at A in the cut. The first thing the boss roller in a rolling mill does when he is given a



A CAUSE OF ERROR IN GAGING

new micrometer caliper is to file a corner in the circle as shown by the dotted line B. With the circular throat the metal is frequently gaged when in the position as indicated at C.

EDITORIALS

Why Some Good Engineers Are Unknown

AMERICAN manufacturers are noted for the freedom with which they exchange experiences and by so doing they all benefit. In no other way can we account for the great advances we have made in manufacturing methods. And yet there are cases where some of our most brilliant engineers and designers are comparatively unknown to their brother engineers, because their work has been the development of special machinery or methods, which are not shown to any but the intimate friends of the concern.

Such conditions affect the reputation of an engineer by an enforced hiding of his ability—and they may also easily lessen his chance of being chosen for bigger and better jobs in other places.

One of the best machine designers and production engineers in the country who has so developed his company that it easily leads in its line, is not widely known in either of his capacities. Engineers in general think of him as the general superintendent of a successful firm, but only a few of his intimates know how great an engineer he really is.

Young engineers should consider this phase of the question when asked to take positions of this kind. They should consider its handicaps as well as its good points. For every engineer owes it to himself and to his family to avoid handicaps of all kinds. Remuneration and future prospects should offset such hiding of his engineering light under the bushel of secrecy.

What Is a High-Grade Machine?

WHAT is a high-grade machine? We talk rather glibly and sometimes a bit loosely about high- and low-grade machines. Just what do we mean and how far does the price influence our judgment in the matter?

Suppose we take an automobile as an example; who can say just what puts one car into the high-grade class and relegates another to medium- or low-grade? Is it the quality of the material, or the workmanship, or both? Is it the lines of the car, the design of the motor, transmission, etc., or shall we judge entirely by the service it renders? If so, this must include first cost, cost of upkeep, reliability and general satisfaction to the owner.

When it comes to service, reliability, cost of upkeep and most miles for the dollar, the record does not always lie with the high-priced cars. The question of easy riding and general satisfaction might alter this verdict but there are so largely psychological matters as to be difficult of solution. It is not necessarily a question of size, weight or high price, because there have been cars claiming all three of these qualifications, which rode hard and were unreliable.

The quality of material can be judged very largely by the weight of the car. It is very evident that a heavy car does not require the same grade of material as a light car which stands up under the same service. Just as airplane motors require the highest-grade material to secure strength with light weight, so a light car, which stands the punishment of the roads, must be built of higher-grade material than is necessary in a car weighing from 50 to 100 per cent. more.

* * *

There are those who believe it is impossible to build a high-grade car in quantities; that each part and each operation must be fussed over separately and hand-fitted if it is to be a really good job. This attitude, however, belongs to the past and not to present-day engineering or manufacture. It is hardly to be questioned that modern manufacturing methods secure greater uniformity of product than is possible by hand work.

Some may claim that while the product may be uniform, it must be "uniformly bad;" but experience hardly bears out this contention. A careful study of the product of those motor shops which turn out large quantities will show a very close adherence to standards. The limits allowed in quantity production are usually less than in the shops building but a few motors. This is made necessary by the time required for assembly where large tolerances prevail.

* * *

Pistons, piston pins, piston rings, connecting-rods and crankshafts all receive careful attention in some shops. Pistons which come a few thousandths large are saved for repairs requiring oversize pistons. But the parts assembled in the motor are apt to fit as closely as in the higher-priced motors.

What then makes the difference in the grade of an automobile, since we have taken that as a subject for discussion?

Given accurate parts of good material, we still have the assembling department which can make or mar the quality of a motor and other parts. Accurate parts can be so carelessly assembled as to insure an unsatisfactory motor. Crankshafts and camshafts can be sprung by injudicious handling. Failure to have bearing surfaces thoroughly cleaned and oiled may easily mean serious damage to a new motor. Fitting connecting-rod bearings on the crankshaft with a hammer does not mean a long-life motor—it means overhauling in a short time instead, no matter whether this is done with a high- or low-priced car.

The care in assembling makes a great difference in the noise or quietness of a motor when it comes to valve tappets, push rods, etc. These points are sometimes slighted in the cheaper cars. But how far do they affect the service rendered?

Of the four factors—design, material, accuracy of parts and assembling—which plays the greater part in making a high-grade product? And just what do we mean by a high-grade machine of any kind?

Standardization and Interchangeability

THE letter which follows give the experience of a well-known engineer on the subject of "Standardization and Interchangeability," as brought out by the article on page 1143, Vol. 50. The subject is of vital importance to those who are considering production carefully and from various angles:

In taking up the meaning of the word standardization, we find in general conversation that there are different interpretations of this word by some of our most skilled men. Standardization of some things is now in existence, but in the machine-tool industry, we all know, it is not given much consideration. Every manufacturer of machine tools is thinking of himself. His mind is constantly on the alert on his own product. There are certain things about his machines that must be kept in mind at all times. If he changes the design, there are certain things that must be kept standardized.

This question has been discussed with me by visitors from time to time and the more we talk of standardization the more confused the question seems to become. Assume that there are four important machine tools that are used in quantities, and they are lathes, milling machines, planing machines and screw machines. Of course, there are others just as important, but take the lathe industry for example. To reach standardization in lathe manufacturing coöperation of the different firms would have to be in existence. Take for instance, the taper holes in the spindle of a lathe. One company uses one taper; another uses something different. They all vary in the length of the taper in their spindles on the same capacity of lathe. The top of the carriage in the center of the machine will vary in most lathes. From the top of the slide to the center of the machine would vary materially. The size of the T-slot and the depth of same for toolpost in most cases is different. The same may be said of the four different styles of machines, the shapes and dimensions are all opposite from another.

Standardization and Competition

If all lathes were made standard in various ways, competition would not be so keen as it is today, from the standpoint of improved product. The different styles of machines emanate from the different thinkers. Improvements that are brought forward are intended to supersede what is being made at the present time. If you interfere with the thoughts of the designers to the extent of expecting them to keep up standardization, they cannot deviate in design to such a great extent, except as is agreeable to all the lathe manufacturers. The life of trade is the improvements made in a machine tool. It is a talking point for the salesman. It is interesting to the possible purchaser. You explain to him the improvements, which are altogether different from any other make. The possibility of greater output or the chances of a better product is also of interest.

The more difference we have in design, forgetting standardization, the greater effort is put forth by all thinkers along the lines of new things. Take this away and you haven't much left. The incentive must be there to try and improve over the other fellow in every way posssible, regardless of the size or shape of the parts you have in mind that are going to bring about this improvement. Anything that retards or interferes in any way with minds that are capable of originating new things, stops interesting improvement.

For many years the thoughts of standardizing screws of all descriptions have been discussed back and forth, but nothing ever came of it. Threads of various kinds vary more or less, and you would think it a simple proposition to be able to convince the average manufacturer of the ease with which he might change from a V to a U. S. standard thread.

It is true that there are some things which are standard and there are a vast multitude of things which are not; and to my way of thinking this will continue for all time. I do not think there is any sense in attempting to standardize machine tools, because to change our design the manufacturers of any particular tool would all have to get together and agree on certain alterations. This, I am afraid, would retard progressiveness, pride and some conceit in your ability, which is essential to develop new ideas.

In some instances, outside the machine-tool business, standardization is a reality. In the automobile business, engines that are made by the thousands by some companies and used by a vast number of automobile manufacturers, are all standard. There are other parts about automobiles that are purchased in the open market and manufactured in great quantities that are, of course, all duplicates. But the reason this happens is because of the immense quantities that make it interesting for outside capital to invest in producing these parts for the automobile manufacturers, usually for less money than they could produce the parts themselves.

The machine-tool business, however, is not in this class. The number produced is not great enough of any particular design of machine. For this reason I am strongly inclined to believe that the machine-tool line will remain about as it is for all time, everyone manufacturing what they think is best for the work they have in mind to be done, regardless of what their competitors may be manufacturing.

As to interchangeability, my opinon is that in some cases this is overdone and in others more or less neglected. It is an easy matter to go to extremes in interchangeability. Machinery of various kinds means that there are certain parts that are active which naturally wear out, and it is vital that all such pieces can be purchased from the manufacturer in duplication. Also, there is a vast number of parts in most any style of machine that are slow moving and practically never wear out, and if interchangeability is considered all through the machine, tolerance is the big thing to have in mind.

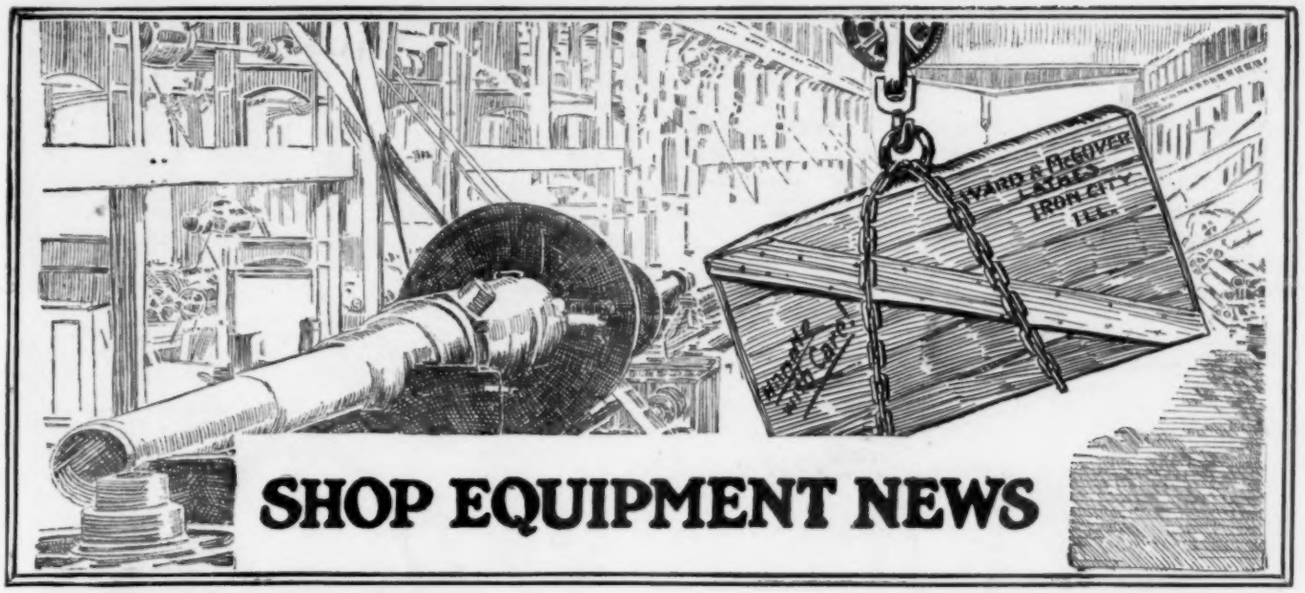
While some pieces require a tolerance of 0.0005 in., this does not necessarily mean that all parts throughout the machine should be made as close as this figure. It is my candid opinion that the closer you come to interchangeability, using good judgment on tolerance, the better the machine produces and at less cost. The closer you machine the parts, the less labor there is in the assembling department.

If properly designed jigs and fixtures are provided when beginning to manufacture an article of any kind, almost regardless of its size, a most satisfactory article can be produced. If the nearest approach to interchangeability is desired, we must not be afraid of spending considerable money in both designing and making the tools and fixtures. We must remember that this is only an initial expense, and that it is soon wiped out by the saving in the assembling department, and in the satisfaction which customers find in the machine.

Interchangeability is really up to the mechanical departments, and common sense should govern the limits in all directions in order to produce as cheaply as possible, always having in mind good workmanship. For example, any of the four machines previously mentioned should have fixtures for every hole that is drilled, bored, reamed or tapped. There is no necessity for laying out holes in a machine tool, because the moment you commence that you are departing from duplication.

Surfaces of all descriptions, if you are equipped properly, can be produced to exact dimensions. The facts are, many troubles that people may have in producing accurately and cheaply come about by faulty thinking in not being as careful to fit up in the right manner to produce as they were in the actual design of their product.

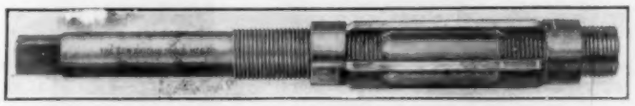
J. P. Brophy,
Vice President and General Manager,
Cleveland Automatic Machine Co.



SHOP EQUIPMENT NEWS

New Britain Expansion Reamers

The New Britain Tool and Mfg. Co., New Britain, Conn., is now marketing a new line of expansion reamers that are made in sizes from $1\frac{5}{32}$ to $4\frac{1}{8}$ in. in diameter inclusive. The reamers consist of three parts, the body, adjusting nuts and blades. The body is provided with

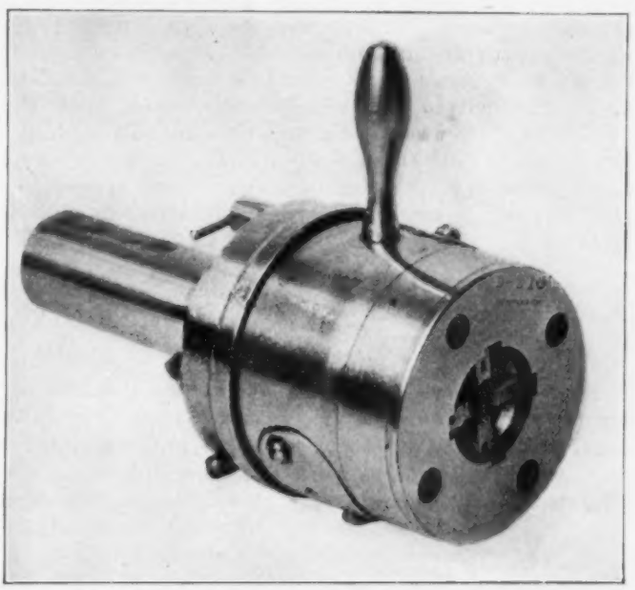


NEW BRITAIN EXPANSION REAMER

taper grooves and threads cut in two places, a portion of the larger diameter being left free from threads in the center to give the blades ample support. The blades are tapered and beveled at each end so as to be held firmly by the adjusting nuts and the adjustment is made by moving the blades up or down in the taper grooves. The reamers are made with either five or six blades, the six-blade reamers having the blades unevenly spaced to prevent chattering. The largest reamer has an expansion of $\frac{9}{16}$ in. Blades can be furnished made of either carbon or high-speed steel as desired.

Victor Self-Opening Die Heads

The Victor self-opening die heads, recently placed on the market by the Victor Tool Co., Waynesboro, Penn., are somewhat similar to the collapsing taps previously manufactured by this company in that the chasers are supported in individual plungers having a $14\frac{1}{2}$-deg. angle. The chasers are held in these plungers by a slot fitting into a tongue milled in the plunger. The plungers are held in a scroll ring or collar that is said to insure absolutely simultaneous action in opening or closing the head. This construction also permits giving a bearing to the back of the chasers their entire length. The die heads are automatically opened as soon as the travel of the turret is stopped, or the head can be opened at any point by retarding the travel of the turret slide by the handle shown. The shank can be made hollow in order to cut any length thread desired, and special shanks can be furnished to customers' specifications. The heads are adjustable, having a variation of about $\frac{1}{32}$ of an inch, either over or under size, and the adjustment is made by two knurled thumb screws at the back of the head, one screw for adjusting, and the other acting as a lock screw. The head is graduated to indicate the proper adjustment. Each head is regularly furnished with a roughing and finishing attachment operated by a small lever at the base of the head. This sets the dies back about 0.010 in. for the roughing cut and the return of the handle to the opposite side sets

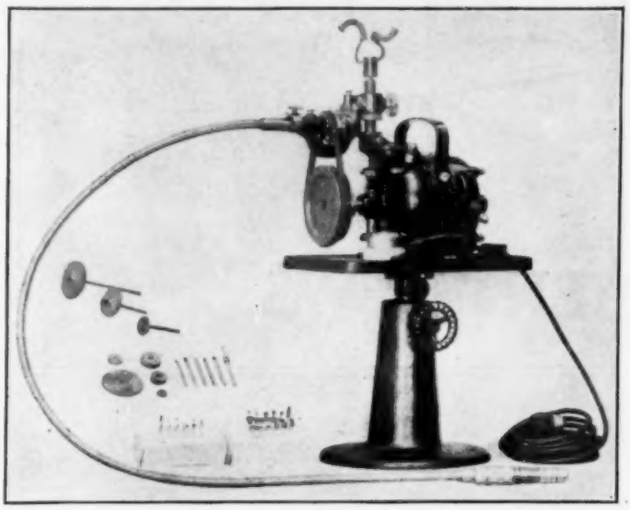


VICTOR SELF-OPENING DIE HEAD

the dies for the finished diameter to which the head has been adjusted. Right- or left-hand threads of standard or special pitches can be cut, and standard heads will cut to within $\frac{1}{4}$ in. of a shoulder. If desired the chasers can be extended through the cap, permitting closer threading. The chasers can be easily removed or replaced by removing the cap and lifting the chasers out of the plungers. The head is entirely closed so that there is no way for chips and dirt to enter, and all parts are interchangeable. The body shank and plunger collar are made of 50-point carbon steel, while the chaser plungers are of tool steel, the chasers themselves being of high-speed or carbon steel as desired.

Haskins Die-Sinker's Grinding Outfit

The R. G. Haskins Co., 547 West Washington Blvd., Chicago, Ill., has developed a flexible-shaft grinding outfit intended for die sinking or other work where it is desired to obtain a good finish in pockets or recesses. The outfit consists of a ⅛-hp. electric motor mounted on



HASKINS DIE-SINKER'S GRINDING OUTFIT

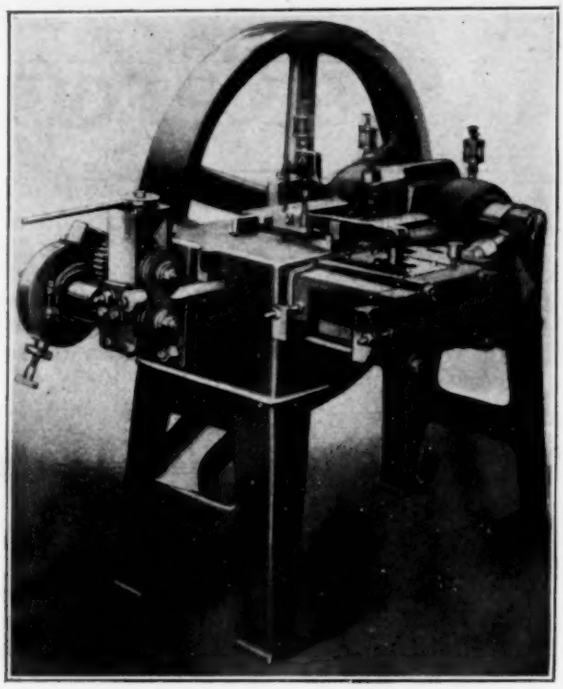
an adjustable base so that it may be raised, lowered, or swung around to any desired position. This motor runs at 1800 r.p.m. and is belted to a countershaft through a V-belt running on two step cone pulleys, giving speeds to the countershaft of 4000 and 6000 r.p.m. This countershaft may be raised or lowered to adjust the belt tension and connects direct with the flexible shaft that ends in a small handle with a chucking device to hold the tool arbor. The tools consist of small grinding wheels and burrs of various shapes and sizes, as well as small high-speed steel burrs or milling cutters.

Kent ¼-Inch, Solid-Die, Single-Stroke Heading Machine

The Kent Machine Co., Kent, Ohio, is now marketing an improved solid-die, single-stroke header, with a capacity up to ¼ in., that is said to have advantages from the standpoints of construction, maintenance, and operation. The principal features of the machine cited are a scotch yoke mechanism with solid wedge adjustment that replaces the usual connecting rod with right- and left-hand thread adjustment; a cut-off that has great strength and large wearing surfaces; an accurate and flexible friction feed; convenience of assembling or dis-assembling for repair or inspection; and small floor space.

The machine is said to be strong and heavy in design, with the metal located to withstand the stresses to which a header is subjected. The bed frame is reinforced to resist torsional or distorting forces set up when heading special non-symmetrical heads. The bearings for the crankshaft are of special alloy bronze and are located close to the crank pin, in order to prevent any springing or bending action. It is stated that the scotch-yoke mechanism used for driving the cross-head does away with any flexibility due to angularity of connection, and that the vibration set up by an oscillating connecting rod is eliminated. The flywheel has a tapered square hole that fits on the end of the shaft, this having the form of the frustrum of the square pyramid. This method of construction gives a positive drive and ease in dis-assembling. The cut-off mechanism is stated to have large wearing surfaces and liberal adjustment for wear. It is said to be very accessible in case repairs are necessary, the removal of four nuts opening up practically the entire cut-off actuating mechanism.

The friction feed consists of two grooved feed rolls actuated by a friction device which is said to give very accurate results. A feed stop finger is provided to look after any over feed setting of the feeding arrangement, although the accuracy of the feed is said to relieve this finger from any great amount of work or pressure. The length of feed is regulated and controlled by the knobs projecting from the lower part of the feed disk at the left. The feed may be instantly thrown out of action by a one-eighth turn of the lever located on top of the feed roll support.



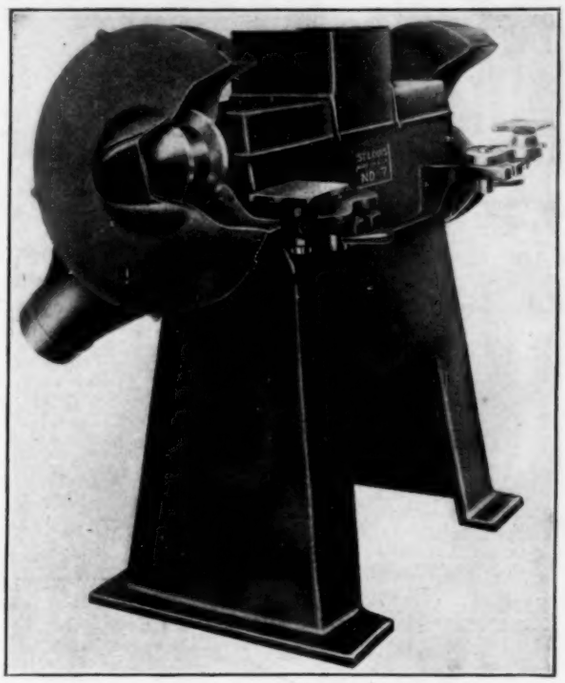
KENT ¼-INCH, SOLID-DIE, SINGLE-STROKE HEADER

The machine is laid out on the unit design principle and is said to be very accessible. For example, by removing the gibs used to hold the cross-head in place, the entire cross-head and connection with crank may be lifted out without disturbing other parts. The cut-off and feed arrangements may be removed from the bed as units. It is stated that the adoption of the scotch-yoke mechanism has reduced the size of the machine to such an extent that the saving in floor area of a battery of these machines is quite material.

St. Louis Grinding Stands

The St. Louis Machine Tool Co., 932 Loughborough Ave., St. Louis, Mo., has just placed on the market a new line of floor type grinding stands. These machines are made in three sizes, Nos. 7, 8 and 9. The arbors used are of 40-point carbon steel with coarse-pitch square threads, and are fitted with either single or cone

pulleys as desired. The bearings are supplied with oil chambers which can be drained through pipe connections at the back. The bearings are lubricated by chains



ST. LOUIS GRINDING STANDS

Made in three sizes, Nos. 7, 8 and 9, the following specifications being given for these three machines, respectively, in each case: Wheels recommended, 18 x 3 in., 20 x 3 in., 24 x 4 in.; diameter of arbor in collar, 1¼ in., 1¾ in., 2 in.; length of arbor, 52 in., 60 in., 65 in.; distance between wheels, 40 in., 44 in., 48 in.; height to center of arbor, 34 in., 34 in., 34 in.; size of base, 23 x 24 in., 23 x 24 in., 25 x 38 in.; plain pulley, 7 x 5 in., 8 x 5½ in., 9 x 6 in.; speed of countershaft, 465, 382, 358 r.p.m.; weight, 700, 775, 1000 lb.

and oil grooves. The countershafts are of the standard, double-brace, self-aligning, babbitted, ring-oiling type, with self-oiling loose pulleys.

Flather 7-in. Manufacturing Lathe With Ball-Bearing Cone

The Flather Manufacturing Co., Nashua, N. H., is now marketing a new 7-in. manufacturing lathe that has unusual features in that the cone is mounted on a set of ball bearings, while the spindle is of the floating type mounted on separate bronze bearings. Fig. 2 shows the design of the headstock. The machine is a manufacturing lathe and has been designed to supply the demand by manufacturers and toolmakers for a standard, rigid, compact, high-speed, screw-cutting engine lathe for accurate work within its capacity, which is about 8 in. over the ways and 15 in. between centers, with a bed length of 36 in. The bed is broad and deep, is braced with cross webs and has bench legs cast integral. In case it is desired to use the machine as a floor type, it can be bolted directly to a pan and legs that can be supplied. All beds are planed and scraped to receive the taper attachments, which are interchangeable on any of the machines.

The headstock has long bearings on the bed and is webbed. The spindle is of high-carbon steel with a ¾-in. hole bored through to accommodate a draw-in chuck with collets up to ½ in. in diameter. The front end of the spindle is reamed to a Morse taper. The spindle bearings are of special bronze, and the cone,

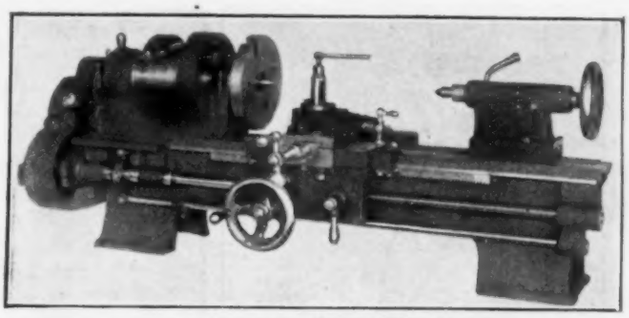


FIG. 1. THE FLATHER 7-IN. MANUFACTURING LATHE

Swing over ways, approximately 8 in.; distance between centers, 15 in.; length of bed, 36 in.; hole through spindle, ¾ in.; maximum capacity of draw-in collet chucks, ½ in.; taper in front end of spindle, Morse No. 3; width of belt, 1¼ in.; spindle bearings, bronze; cone bearings, ball type; back gear ratio, 7 : 1; lead screw, ⅝ in. in diameter, with 10 acme threads; travel of cross slide, 4½ in.; travel of compound rest, 1½ in.; countershaft, two-speed, double friction type; weight of bench type machine, 300 lb.; weight of floor type machine with pan, 400 lb.; floor space, 24 x 42 in.

which runs on its own ball bearings, is for a 1¼-in. belt. This cone is mounted on bearings held in separate housings from those carrying the spindle boxes. This method of construction allows the spindle to run freely and takes all belt pull off the spindle bearings. Back gears are provided, the ratio being 7 to 1.

The carriage and apron are heavy, the carriage being arranged with long bearings and felt wipers. A feed stop is incorporated that can be set for any length of feed, this stop automatically disengaging the feed clutch when the required length has been reached. The lead screw is held by a middle bearing on which the step nut acts, leaving the screw free at the back end

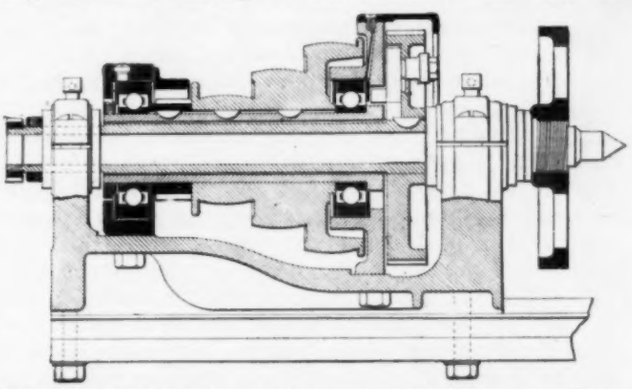


FIG. 2. A CROSS-SECTION OF THE HEADSTOCK SHOWING THE METHOD OF CONSTRUCTION OF THE FLOATING SPINDLE

for expansion and contraction. The nut is of cast iron, and is operated by a cam milled to allow the nut to be closed firmly on the screw. The cross slide is graduated for adjusting the compound rest and the cross-feed nut is so arranged that it does not have to be disconnected when using the taper attachment. A contershaft of the two-speed double-friction type is furnished and is operated by double toggle joints.

Cochrane-Bly Milling and Shaping Machine

The Cochrane-Bly Co., Rochester, N. Y., has recently made a number of improvements on its universal milling and shaping machine, and has also added several new models. The machine is now built as a duplex universal vertical milling and shaping machine, as shown in Fig.

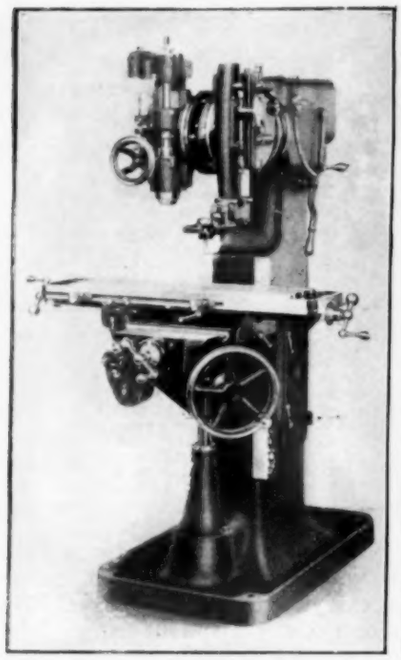


FIG. 1. COCHRANE-BLY NO. 14 DUPLEX UNIVERSAL VERTICAL MILLING AND SHAPING MACHINE

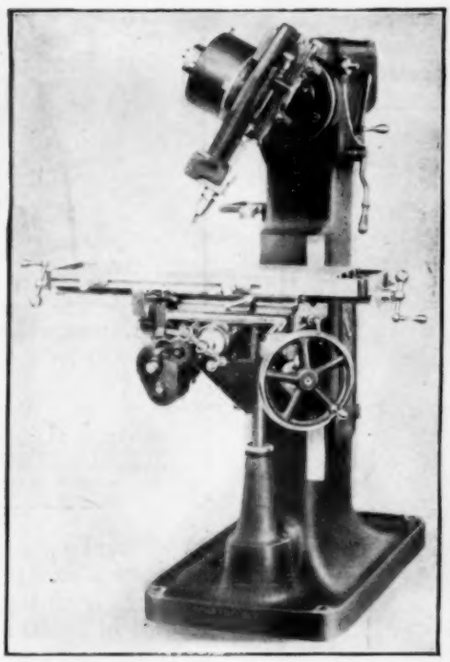


FIG. 2. THE UNIVERSAL VERTICAL SHAPING MACHINE WITH HEAD INCLINED FROM RIGHT TO LEFT

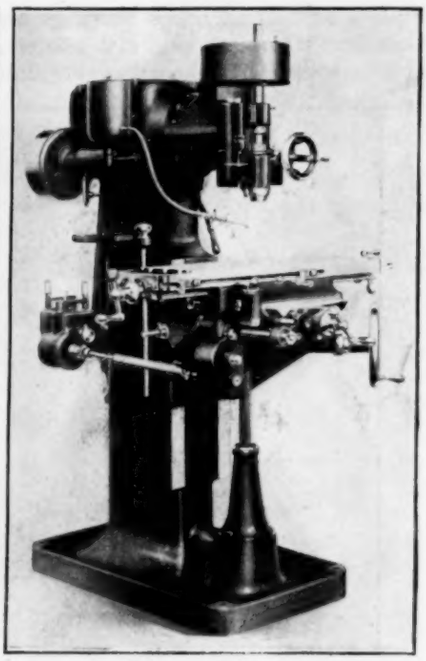


FIG. 3. THE PLAIN VERTICAL MILLING MACHINE WITH FRICTION CLUTCH AND SINGLE PULLEY DRIVE

Size of table inside oil pocket, 9 x 29 in.; longitudinal table travel, 18½ in.; transverse table travel, 9 in.; vertical table travel, 18 in.; size of 3 T-slots, ⅝ in.; adjustment of center head, 360 deg.; adjustment of milling head, front and back, 45 deg.; adjustment of shaping head, front and back, 40 deg.; speeds of milling spindle, 55 to 330 r.p.m.; maximum speed of high-speed milling attachment, 1400 r.p.m.; maximum distance from table to spindle, 20 in.; maximum distance from table to tool head, 18 in.; distance from center of spindle to column, 13 in.; strokes per min., 25 to 150; taper hole in spindle, B. & S. No. 9; hole through spindle, ¾ in.; feeds per revolution of milling spindle, 0.002, 0.004, 0.006, 0.008, 0.016, and 0.024 in.; feeds per stroke of shaping ram, 0.0025 to 0.020 in.; speed of drive pulley, 500 r.p.m.; size of drive pulley, 10 x 3 in.; net weight, 2100 lb.

1; as a universal vertical milling machine; as a universal vertical shaping machine, as shown in Fig. 2, and as a plain vertical milling machine, as shown in Fig. 3.

The universal head adjusts through the complete circle, and the shaping and milling heads adjust independently 40 deg. front and 40 deg. back of vertical. The milling spindle has an adjustment of 3½ in. with hand feed, a micrometer screw being provided on the spindle housing to gage the depth of milling or drilling. The spindle is hollow in order that draw bolts may be used for holding milling cutters, split collets, etc. The stroke of the shaper ram is adjustable up to 6 in., the tool head is adjustable on the ram through the full circle. The clapper block is positively operated by a toggle-link and adjustable dogs. The crank arm or link is made of solid steel and provision is made for taking up wear on both the crankpin and the link.

The drive is through a friction clutch pulley and two cones of gears, the latter running in a bath of oil. All the gears used are made of steel and those in the driving train are hardened. The motion of the spindle can be reversed or the drive can be disengaged and the spindle revolved freely by hand. A locking pin is provided in order that the spindle may be locked while changing cutters. The clutch pulley has an oil reservoir in order to insure thorough lubrication over considerable periods of time. A cone brake opposes the clutch, and as this is engaged when the clutch is disengaged it serves to stop the machine quickly. Five changes of speed may be obtained by shifting a lever located within easy reach from the operating position.

The plain milling machine has 10 spindle speeds and 12 changes of feed, and will take any of the standard attachments furnished with the universal machine.

A very useful and important part of the outfit furnished is the circular tables. Fig. 4 shows a 12-in. circular table with hand feed and 10-in. compound circular table mounted in combination, but either of these tables can be obtained singly. The 12-in. circular table is also made with a dividing attachment. The 10-in. compound circular table has a 5-in. transverse movement and the body is graduated in degrees, the dial reading to 10 minutes of arc. It is stated that these attachments are very useful in drilling and boring jigs and in combination with the universal feature of the machine allow milling and slotting to be done at almost any angle, without removing the work from the machine. By using the circular and compound tables in combination, dies and other parts can be machined with any number of centers and two or more curves blended.

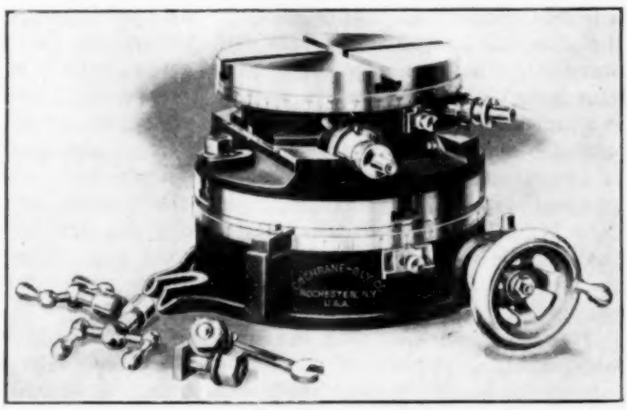
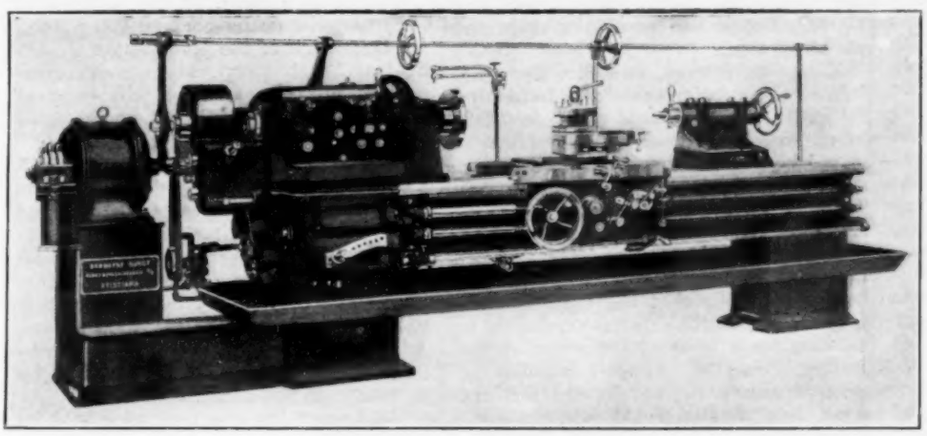


FIG. 4. THE 12-INCH CIRCULAR TABLE WITH HAND FEED AND 10-INCH COMPOUND TABLE MOUNTED IN COMBINATION

In addition to the circular compound table, a number of other attachments are furnished, such as plain milling vise, drill chuck, spring chuck, collets, sleeves for Morse and B. & S. tapers, draw bolts, centers, and expanding arbors. A simple motor drive can also be applied if desired.

Sundt Type A. S. Lathe

Brodrene Sundt, Lakkegaten 55, Christiania, Norway, has recently placed on the market a new line of lathes known as the type AS high-speed machines, these being equipped with a patented millimeter screw cutting arrangement and with a large pitch cutting arrangement. The machines are made in five sizes, with swings over the ways of 430, 504, 600, 720 and 860 mm. The machines are made in two types, the special type shown which is equipped with water pan and direct-motor drive, and the standard type which is practically the same except that the water pan and motor drive are omitted.



SUNDT TYPE AS HIGH-SPEED LATHE

Made in five sizes, Type AS 8, AS 10, AS 12, AS 14 and AS 16, having swings over the ways of 430, 504, 600, 720 and 860 mm., respectively. Specifications for Type AS 12 machine: height of centers, 292 mm.; swing over ways, 600 mm.; swing over carriage, 430 mm.; length of bed, 2440 mm.; distance between centers, 900 mm.; width of bed, 460 mm.; front bearing, 100 x 156 mm.; hole through spindle, 55 mm.; diameter of tailstock spindle, 70 mm.; back gear ratio, 24 : 1; spindle speeds, 8 to 384 r.p.m.; horsepower required, 8.

The headstock is so designed that different gear ratios may be coupled in direct connection with the lead screw and by this arrangement the total number of pitches obtained in the ordinary way are multiplied by the number of gear ratios in the headstock. By this arrangement, pitches up to 12 in. per revolution of the spindle can be obtained.

The machines are made with one lead screw for inch pitches and one for millimeter pitches; the latter, being finished with a keyway, also serves as a feed rod. In case it is desired to cut metric threads a greater part of the time the inch thread may be cut in the feed rod and the metric thread on the screw. The apron has two nuts, one for each thread, both being operated by the same handle, so that only one can be used at a time. Both screws run at the same speed, and either may be uncoupled while the other is running. The cross slide screw has metric threads and this is connected to the feed rod so that spirals may be cut in a plane face.

The headstock is of the gear-box type. The cover may be opened to expose all gearing, the shafts and gears being mounted in the lower half. The box is oil tight and the gears, which are of steel, run in a bath of oil. The spindle is of nickel steel, hardened and ground to size, and is hollow, the bearings being of bronze of the ring-oiling type, while end thrust is taken up by a ball bearing. The drive is through two pulleys, one for forward and one for reverse, these being connected by friction clutches. The motor drive is very similar, the friction clutches being used for forward and reverse speeds.

The carriage slides on V's on the bed and has an automatic oiling and wiping mechanism for the V's. By means of a special device the carriage may be automatically moved back and forth on the bed while the spindle is at rest. The apron contains the reverse mechanism for the feed and is said to be very strongly built. With the change gear box in connection with one set of spur gears and the gear ratios of the headstock, 342 different pitches can be obtained, 167 for inch pitches and 175 for millimeter pitches, by simply manipulating the different handles and without changing any gears. Another advantage claimed for the system used is that in cutting metric threads modul pitches can be cut by means of a few extra change gears, 11 gears being necessary to cut 69 modul pitches ranging from 0.75 to 60.

A toolpost is used that accommodates four tools, one half turn of the handle raising the post ¼ in. from its seat when turning around. A lubricant outfit consisting of water pan, pump and piping can be furnished if desired, as can also direct motor drive as illustrated. Other attachments, such as taper attachments, stops for the carriage feeds, extra back toolholder, and double toolholder can also be furnished.

Boxing Products as Soon as Finished

By Peter F. O'Shea

Many plants find it convenient to let finished product accumulate in stock until there is enough to put in a day or so boxing it up. In the meantime, however, dampness in the atmosphere may rust it, if it is of steel; rats may run over it at night and discolor it, and a number of things may happen to spoil its appearance if it lies unwrapped and exposed.

The pipe tool plant of the Greenfield Tap and Die Corporation found that time was lost in restoring the finish of such products, and the manager, therefore, changed the system to route all products, as soon as they were done, to a packing bench. Each individual piece is wrapped in tissue paper, and lots of half-dozens or dozens are placed in wooden boxes and nailed up at once all ready for shipment.

Pipe vises, for instance, are packed by the half-dozen, making the box easy to handle and proportionate to the size of orders which come in. Pipe wrenches of small size are put in dozen lots. The boxes are then stacked and kept in stock in this fashion, ready to apply on order and be shipped. The cost of doing it in this way is simply the cost of having employees detailed to spend all or part time in packing each day's output.

Sparks from the

The Bill to Improve the Patent System

The Patent Office has worked for many years with too small and poorly paid a force to properly function. Insufficient time is allowed the examining corps to search for the best references. Since a patent is invalid if antedated by any other patent or publication, domestic or foreign, the field for search, especially in some of the arts, is enormous, and the office has issued a large number of invalid claims. The money value of a patent is largely proportional to the degree of confidence that may be placed in its validity.

The condition of the patent office has aroused the activities of many organizations interested in patents. The National Research Council through a committee composed of scientists, lawyers, and inventors has submitted three bills to the Committee on Patents in Congress to improve the patent system: (1) by the establishment of a patent court of appeals consisting of a chief justice appointed for life by the President and six associate circuit or district judges selected by the Chief Justice of the U. S. Supreme Court from among the present federal judges for terms of six years each, which shall be the final court of appeals from the United States District Courts for all patent cases; (2) to increase the force and salaries in the Patent Office; (3) to separate the Patent Office from the Interior Department, and thus make of it a bureau of more importance and dignity. These bills have been approved by the American Society of Civil Engineers and several associations of American manufacturers.

The Committee on Patents of the House of Representatives gave hearings on these bills July 9, 10, and 11. The Research Council sub-committee through its chairman, E. J. Prindle of New York, by notifying the manufacturers and inventors, assembled quite a number of persons who wished to present their views to the committee on the merits or demerits of these bills.

F. P. Fish, a patent attorney of Boston, pointed out the advantages that would be obtained by passing the bill establishing a court of patent appeals since it would simplify and shorten litigation and would prevent the present practice by which after a patentee has been defeated in one circuit, the litigation may be started all over again in another circuit, because a final decision in the proposed court would settle the case.

E. J. Prindle of New York, pointed out how the patent system had helped to develop all commercial arts, especially emphasizing its influence in developing harvesting machines, printing presses, telephones, typewriting machines, textile machinery, etc., and that Congress should be at least willing to pay for the patent system the fees that have been paid by inventors to sustain the Patent Office, especially now that the work has been increased to such an extent that it is impossible to do it properly with the present force. Instead of doing this, Congress has failed to appropriate by more than $8,000,000 the money paid by inventors over and above what it has cost to sustain the patent system.

Elmer A. Sperry, and Mr. Sprague, told of their experiences and hardships in getting capital interested in their inventions, and how much easier it would have been if when they went to the capitalists and showed them their inventions, they could have been assured that the patents were valid.

Judge Learned Hand of the District Court of New York told the Committee the attitude that the federal court judges would probably take relative to serving for a term of six years on the Patent Court of Appeals at the increased salary carried by the bill and went into details as to why in some cases it would be impractical for a district judge to leave his district for a six year period, pointing out, however, that there would be no difficulty as to the circuit judges, and that the Chief Justice would probably come to limiting his selection for the Patent Court of Appeals to the circuit judges.

Hon. Thomas Ewing of New York, former Commissioner of Patents, outlined the advantages that would be gained by separating the Patent Office from the Interior Department in getting more recognition from Congress. Since it is unlike all the other bureaus of the Interior Department, and in providing for it, comparisons with the other bureaus would not have to be made if it were an independent bureau.

Wesley G. Carr of Pittsburgh, representing the Westinghouse Electrical Manufacturing Company, told the committee that it would be almost impossible for his company to make any great advance without adequate patent protection. He pointed out the enormous expense in launching new enterprises, and stated that few manufacturing concerns would take this risk unless they were given a short term monopoly to guarantee their recouping themselves in case the improvement proved to be popular.

Delos Holden, representative of Thomas A. Edison, told of the great expense that Mr. Edison had gone to in developing such inventions as his storage battery, phonograph, etc., which never could have been done unless he had been assured of some reward by a patent monopoly.

Hon. James T. Newton, the Commissioner of Patents, outlined to the committee, the great need of the Patent Office for financial assistance at this time in securing more and better help. He stated that since the increase in the cost of living about 25 per cent. of the examining corps were leaving the office every year, that the Civil Service Commission could not furnish eligibles at the present salaries, and that he was picking up any one he could get that could do the work for the present low salaries.

Several other distinguished inventors, manufacturers, and patent lawyers reinterated the main points brought out at the hearing, and emphasized the great influence that the patent system has had on the development of manufactures and how it deserved the best care, protection, and encouragement of Congress.

It is to be hoped that the committee will present to Congress such bills as will relive the present situation and keep American manufacturers at the head of the world's progress and development.

Fall Meeting of the American Electrochemical Society

The tentative program for the Chicago meeting of the American Electrochemical Society, Sept. 23 to 25, 1919, has been announced. Several sessions will be held jointly with the American Institute of Mining and Metallurgical Engineers, which meets in Chicago during the week of Sept. 22.

On Tuesday, Sept. 23, the society and institute will go by boat to Gary, Ind., for inspection of the plant of the United States Steel Corporation. A symposium on electric steel will be held on the boat and continued at the Congress Hotel in the evening.

Wednesday morning the society will hold a general session and in the afternoon a joint session with the institute in a symposium on non-ferrous electrometallurgy. In the evening a special visit will be made to the electric furnace display at the National Exposition of Chemical Industries at the Coliseum.

Thursday will be devoted to a symposium on catalysis, to be followed by a smoker in the evening.

On Friday the institute may hold its symposium on pyrometry, to which members of the society are invited.

Headquarters of both the society and the institute will be at the Congress Hotel, and according to present plans will be held there.

The American Electrochemical Society's headquarters at the Chemical Exposition will be Booth 229, on the balcony of the Coliseum.

World's Industrial Forge

By E.C.Porter
News Editor

Trade Currents From Chicago and Cleveland Districts

CHICAGO LETTER

Although sales totals are not yet made up for July it is apparent that the record is going to equal, if not exceed, any previous July in the history of the market as the regular summer slump has failed to come. In view of the fact that none of the great corporations are buying to an appreciable fact it is interesting to know where the tools are going.

One dealer's sales last week included the following: A 36-in. lathe and a 36-in. planing machine to a local manufacturer of packing house machinery; a 42-in. planing machine and a 42-in. radial drilling machine to a local drop forge works and, to a Chicago manufacturer of machinery specialties, two large boring mills of different types, a milling and a thread milling machine. Other customers represented automobile body makers, washing machine manufacturers and electric motor manufacturers.

In each case the machines sold were to fill a definite immediate need, this showing that the continued good business is not based on unnecesary buying by a few optomists, but rather on the actual demands of the trades.

Prices are definitely advancing. Most of the large manufacturers of lathes have notified dealers that prices are immediately increased from 12½ per cent. to 17½ per cent. justifying the raise by the fact that labor, materials and overhead expenses are higher than ever before. The newly established lists are equal to or higher than the high-price marks reached last year on all makes.

The market apparently will stand the advance with hesitation, as export orders are helping keep manufacturers busy. A Cincinnati maker of lathes who recently sent a shipment of 30 large machines to Belgium reports that his agent has disposed of the entire lot and requests a duplication of the order.

CLEVELAND LETTER

More prospects for new business in the local machinery field have developed here in the last week than have been seen throughout the entire month. Leading interests take this to mean that the consumers of machinery now are getting on the upgrade, and if present inquiries count for anything, the month of August is likely to develop into the busiest month of the period in recent normal years. As has been the case for the last few months, none of the orders pending are of large proportions, the total alone making for substantial business. A satisfactory feature is that the demand is from more varied sources, although the automobile industry of Cleveland, Detroit and other points in the middle west still leads in the matter of equipment for immediate or nearby delivery.

For some time to come it is figured that most of the business to be placed in this territory will come from local or Middle West manufacturing interests, although as the summer advances there is a perceptible improvement in inquiries filtering through to Cleveland producers and distributors for foreign account. In a few tentative feelers drawn out during the week it is noted that a large amount of ship-building is contemplated by former warring countries, as well as for general manufacturing purposes abroad, and as these inquiries materialize it is figured that a larger amount of bigger equipment will be moving.

Considerable used machinery continues to come forward, and this is finding a ready outlet. Among the latest plants to offer its equipment for the market is the Portsmouth Engine Co., Portsmouth, Ohio, which has been engaged in the production of engines of various types and castings. This plant is being offered intact. It has Baltimore and Ohio Railroad switching facilities, and its combined foundry and machine shop equipment is estimated at a valuation of $80,000. No Cleveland interests have signified their intention of handling the project as yet.

CLEVELAND GETS AXLE PLANT

Incorporation of the L-M Axle Co., of this city, this week, with capitalization of $1,500,000 marks the beginning of a new era in axle manufacture for Cleveland. The company proposes to make double reduction truck axles, invented by Leo Melanowski, who also will be the chief engineer of the concern. Temporary headquarters have been established at 247 Colonial Arcade this city. Officers of the company are: President, Harlen E. Shimmins; vice president, Capt. R. L. Queisser; secretary, James L. Vaughab; treasurer, Louis A. Otto.

* * *

American Chamber of Commerce in Chile

There has been formed at Valparaiso, Chile, an American chamber of commerce for the purpose of promotion of trade relations between merchants of Chile and the United States. Practically all American firms established in Valparaiso are supporting the new organization, and it also is receiving support from many Chilean firms. American catalogs, business literature, etc., are especially desired by the chamber.

Joint Commercial Mission from Europe to Visit America

Invitations extended by the Chamber of Commerce of the United States to Great Britain, France, Italy and Belgium for a joint Commercial Mission to visit this country in the fall have been accepted, according to announcements recently made at the Washington offices of the Chamber. Elliot H. Goodwin, general secretary of the Chamber, and Ben. H. Lambe, associate editor of the *Nation's Business*, arrived in London last week to complete final arrangements.

THE MISSIONS DUE IN SEPTEMBER

The Missions are due to reach the United States the latter part of September to participate, at Atlantic City during the week of Sept. 29, in an International Trade Conference. This conference will be attended, according to present plans, by at least a thousand leaders in American business, who in meetings with members of the Missions will discuss many phases of international trade relations. At the conclusion of the International Trade Conference the plan is for the Missions to tour the country, visiting the chief industrial and commercial centers. The return to Europe will be about Nov. 1.

On the tour, which will be conducted under the auspices of the National Chamber and its member organizations, the Missions, through conferences and public meetings, will inform American business men of the part they can take in the rehabilitation of Europe.

At least two of the Missions will be headed by cabinet members and a government representative will accompany each. Each Mission will include five principals and a number of assistants and secretaries, making a party altogether of from fifty to sixty. The government departments at Washington are coöperating with the National Chamber in arranging for the Missions' stay in the United States.

The main purpose of the visit and of the International Trade Conference to be held at Atlantic City is to acquaint American business men with the situation abroad and to bring about closer relations between this country and her European associates in the war. It is felt that unless the European countries can begin production on a large scale they are faced with a serious danger in that they may not be able to pay for food and clothing which they need to support life itself, that it may be impossible for them to reduce their war debt and that there may be grave danger of social and political upheavals.

The United States, it is pointed out, has a very deep concern in these possibilities because it has been shown that

serious social disturbances in Europe have a reaction in America. If Europe should not get back on its feet commercially and industrially in the near future, American business men believe it would mean American business would lose all chance for a European market for the export surplus of manufactured goods which it is believed will be available in the United States as soon as stocks depleted by war have been replaced.

America must concern itself, it is pointed out, in bringing exchange back to normal as a means of keeping up the volume of export and import trade. Business leaders believe the best American business policy, therefore, is to give Europe the kind of business assistance of which it stands most in need and to refrain from action which would tend to prevent it from resuming its own production.

At Atlantic City all of these questions will be taken up by the Missions and the American business men attending with a view to arriving at some definite plan of re-establishing European credit. The various delegations will be requested in advance to bring data on certain specified subjects to the end that just the kind of information may be given to American business men which will be of the most value.

Trade Conference to Appoint a General Committee

The plan of organization for the Trade Conference contemplates the appointment of a general committee of from twenty-five to fifty men from all parts of the country. From this general committee an executive committee will be selected to have directly in hand all arrangements for all details of conferences and the various visits to American cities. A. C. Bedford, chairman of the Standard Oil Company of New Jersey, will act as chairman of both the general and executive committees. Other members of the executive committee thus far selected are:

Homer L. Ferguson, president of the United States Chamber of Commerce; Thomas W. Lamont, of J. P. Morgan & Co.; Harry A. Wheeler, vice president of the Union Trust Co.; James A. Farrell, chairman of the National Foreign Trade Council; John H. Fahey; George E. Smith, president of the American Manufacturers' Export Association; R. Godwyn Rhett; William Fellowes Morgan, president of the Merchants' Association of New York; Alfred E. Marling, president of the New York State Chamber of Commerce; Joseph H. Defrees, of Defrees, Buckingham & Eaton; Ernest T. Trigg, vice president of the John Lucas & Co.; Theodore F. Whitemarsh, vice president of the Francis H. Leggett & Co.; Lewis E. Pierson, chairman of the board of directors of the Irving National Bank; Edward A. Filene, William Filene's Sons Co.; E. G. Miner, president of the Pfaudler Co.; and Ivy L. Lee.

Information reaching the Chamber indicates that the Italian Mission will be made up as follows: Hon. Dr. Silvie Crespi, former Minister of Italy as Food Comptroller; Comm. Pie Perons of G. Ansaldo & Co.; Eng. G. Quartieri, one of the largest manufacturers of chemical products; Gr. Off. Salvatore Tagliavia, Mayor of Palermo; Hon. Marco Cassini, president of the Union of the Chambers of Commerce of the Kingdom; and a fifth delegate to be appointed by the Minister of the Treasury.

The Belgian Mission

The Belgian Mission probably will be composed of these: Jean Delori, engineer, manager of the Nail and Wire Works in Flanders; Fernand Pisart, manager the Society for the Manufacture of White Zinc; Robert Grisar, manager of the "Maison Grisar"; George Peltzer, representative of the "Textile of Verviers"; and Mr. Canon-Legrand.

The French Mission probably will be headed by Minister of Commerce Clementel.

Court Knocks Out Wire Wheel Patents

Because the hand of Leonardo da Vinci had a way of straying from any portrait he was painting to make a sketch upon its border of some mechanical device that was too early by several centuries for practical application there can be no monopoly by patent of wire wheels for automobiles in this day. Judge Learned Hand in the United States District Court on July 29 dismissed the suit brought by the Wire Wheel Corporation of America against C. T. Silver, Inc., in which infringement of the wire wheel patents of the plaintiff were alleged.

Judge Hand decided that the claim was void because of noninvention. He held that it is to the many sided genius of Da Vinci that the world owes knowledge of a tension wheel which depends for its rigidity upon the fact that the hub may hang from above as well as be supported from below. Successful commercial exploitation of an idea is not in itself proof of invention, said the Court. Such success would support a claim of patent rights, he said, if the device covered by the patent had new features that eliminated the defects in previous methods of construction and made it operate efficiently.

The Court pointed out that the earliest automobiles built in this country had wire wheels. The French style of wooden artillery wheel displaced the wire wheel and dominated the American market until 1911 or 1912. Since then, owing to the introduction of English cars of the highest quality and to energetic advertising, the wire wheel, which had been improved by methods covered by the patent that figured in this litigation, has become a powerful factor in the automobile industry.

"No doubt the wire wheel as such always had its advantages and its apostles," said the Court, "but its adoption did not depend upon some key to unsolved difficulties of structure."—*New York Sun.*

Business Items

The Wagner Electric Manufacturing Co., St. Louis, Mo., announces the removal of its Philadelphia office, service station and warehouse to 1632-34 Sansom St.

The Chicago Pneumatic Tool Co. announces the appointment of N. S. Thulin as special railroad representative on the staff of S. C. Sprague, manager of Western railroad sales.

The Heald Machine Co.'s Detroit office has been moved from 911 Majestic Building to 401 Marquette Building, 75 West Congress St. J. G. Wonn will continue in charge of this office.

The Sherritt and Stoer Co., Philadelphia, has lately extended their machine tool activities and are now agents for the Cockrane Bly Co., Rochester, and for the Taft Pierce Manufacturing Co., Rhode Island. The Cockrane Bly Co. is the manufacturer of the universal shaping machine.

The Grinding Process Tool Co., Detroit, Mich., is the new name adopted on July 1, by the corporation known heretofore as the Detroit Reamer Salvage Co. This firm commenced business about six years ago remanufacturing worn out reamers. The business has since been expanded to take in all kinds of precision metal cutting tools.

The Equipment Manufacturing and Supply Co., Philadelphia, formerly located in the Commercial Trust Building, has opened a new office, store and warehouse at 26 North 5th St. This Company is now the direct factory representative of the Alvord Reamer and Tool Co., A. J. Polk and Son Co., the Liberty Screw Co., the Parker Manufacturing Co., the Herbrand Co., and the American Twist Drill Co., in Philadelphia. In addition to the manufacturing and marketing of machine tools the Equipment Manufacturing and Supply Company now handles a line of contractors' supplies. No recent change has been made in the personnel of the directors of the company, which consists of J. Boyd Coates, president; C. Warren Rainear, treasurer; and F. T. McGuire, secretary.

Personals

Franklin G. Smith, director of the Cleveland-Osborn Manufacturing Co., Cleveland, Ohio, has been elected president of the Cleveland Y. M. C. A. Fred W. Ramsey, of the Cleveland Metal Products Co., has been elected vice president of the organization.

George W. Way, 858 Penobscot Building, Detroit, Mich., has been appointed the Michigan representative of the Erie Crucible Steel Co. Mr. Way was for the last five years connected with the Detroit office of the

(*Continued on page* 294b)

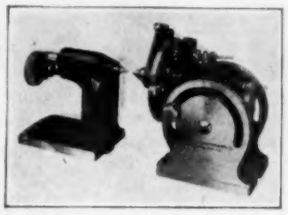
Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Dividing Head, Universal

New Britain Tool and Mfg. Co., New Britain, Conn

"American Machinist," July 17, 1919

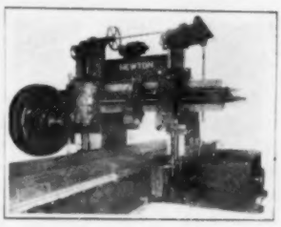


The headstock spindle has a tapered bearing and provision is made for mounting a chuck and an adjustable stop. The spindle is locked by a special clamping device which takes all stress from the index pin. Both the head and tailstock are so machined that they can be placed against a straight-edge when used on a magnetic chuck and still maintain the center in alignment. Swing on centers, 8 in; hole through spindle, No. 2 Morse taper; space required for head and tailstock, 4½ and 3 in. respectively along the table; height in horizontal position, 6 in.; height in vertical position, 5⅞ in.; weight of headstock, 12½ lb; weight of tailstock, 4½ lb.

Milling Machine, Heavy Duty Horizontal

Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Penn.

"American Machinist," July 17, 1919

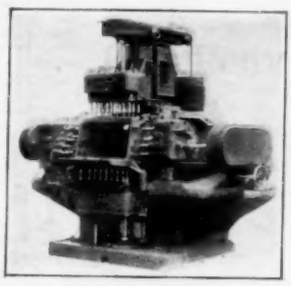


Diameter of spindle through driving wormwheel, 7 in.; diameter of large end of spindle, 11 in.; side adjustment to spindle, 10 in.; width of table on working surface, 42 in.; width of table over oil pan, 49 in.; length of table to mill, 20 ft.; maximum distance from top of table to spindle center, 31 in.; minimum distance from top of table to spindle center, 4 in.; width between uprights, 51 in.; motor for drive, 75 hp., 400-1200 r.p.m.; motor for crossrail lift, 5 hp., 1150 r.p.m.

Drilling Machine, Special

Foote-Burt Co., St. Clair Ave. and 41st St., N. E., Cleveland, Ohio.

"American Machinist," July 17, 1919



Special, four-way, semi-automatic drilling machine that is typical of the line built by this company. The machine illustrated is a 60-spindle four-way affair with the spindles set on fixed centers, making it possible to catch a multiple layout of holes in automobile engine cylinder blocks which would be impossible with spindles of the adjustable type. The machine is semi-automatic and one lever engages the feed for all heads simultaneously. These heads feed in to the desired depth and return to the starting point, where the feed is automatically disengaged. The machines are strictly production machines, the jig being a part of the machine itself.

Press, Arbor and Broaching Combined

Hercules Machinery Co., Union Trust Bldg., Detroit, Mich.

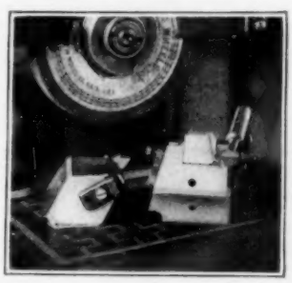
"American Machinist," July 17, 1919

Combines an arbor press and a broaching machine. As an arbor press it is stated that the machine will do, with exceptional rapidity and power, almost any operation requiring pressure, and for broaching it will use either draw or push broaches. The machine illustrated is of 12-ton style and has one lever control. Maximum distance from top of table to end of ram, 34 in.; maximum diameter of hole through table, 4½ in.; driving pulley, 14 in. in diameter, 2¾ in. wide; r.p.m. of driving pulley, 300; speed of ram on fast-down and quick-return travels, 50 ft. per minute; speed of ram on slow or power-down travels, 7 ft. per minute; leverage, 160 to 1; weight, 1750 lb.; floor space, 24 x 42 in.; maximum diameter of work handled, 24 in.

Tool Grinding Block

W. C. Brooks, 1052 State St., Springfield, Mass.

"American Machinist," July 17, 1919



For grinding threading tools from square stock and for grinding boring bars for internal threads. The illustration shows the device in use on both operations. The blocks are so shaped as to grind the tools with the proper clearance. A sliding gage is provided for setting the boring bar at the same angle as the square tool. Three holes are provided so that the device can be clamped on a grinding machine, or it may be used on a magnetic chuck as shown. All parts are hardened and ground.

Truing Tools for Grinding Wheels

Ross Manufacturing Co., Cleveland, Ohio.

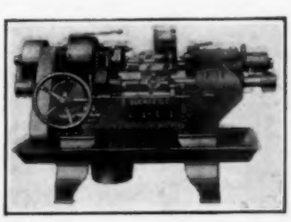
"American Machinist," July 24, 1919

Said to be on a par with a diamond for truing straight-faced grinding wheels. Consists of a hardened-steel cylinder, the surface of which is crossed diagonally by two series of narrow slots at right angles to one another. The depth, size and spacing of these slots are varied according to the character of the work. The ball bearings are inclosed to keep out grit and provision is made for taking up end play. The effect of the light pressure applied with the tool is to loosen the top layer of crystals of the wheel, and expose a new surface of sharp-grained crystals. The maker claims that this action is quite different from the use of a diamond tool.

Lathe, Automatic, "Daniels"

Rockford Machine Tool Co., Rockford, Ill.

"American Machinist," July 17, 1919

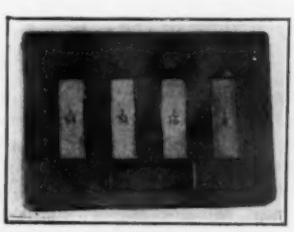


Swing over side carriage bar, 14 in.; swing over cross carriage, 10½ in. distance between centers, 18 in.; travel of side carriage, 12 in.; front spindle bearing, 4⅜ x 6⅜ in.; rear spindle bearing, 3½ x 5 in.; hole through spindle, 1⅛ in.; diameter of spindle nose, 3⅝ in.; threads on spindle nose, 5 U. S.; diameter of tailstock spindle, 2¼ in.; centers, Morse No. 5; diameter of drive pulley, 14 in.; width of belt, 6 in.; spindle gears 6-8 pitch stub tooth helical; reduction from drive pinion to gear, 4 to 1; weight, 3500 lb.

Gage Standards, "I. & C."

Coats Machine Tool Co., Inc., 110 West 40th St., New York City.

"American Machinist," July 24, 1919



A handy set of gage blocks for the small shop which cannot afford or does not need the usual full set of gage standards. Each block is guaranteed by the makers to be correct to one-hundred-thousandth of an inch (0.00001 in.) at 65 deg. F. These sets are designed for use where frequent testing of shop micrometers at various positions in their range is necessary. The set illustrated consists of five blocks, 1/64 in., 1/32 in., 1/16 in., ⅛ in. and ¼ in. in thickness, respectively.

Patented Aug. 20, 1918

Carnegie Steel Co. Prior to this position he was superintendent of the forge and machine shop of the Union Switch and Signal Co.

PHILLIPS F. JARVIS has resigned his position as sales manager for the Sullivan Machinery Co. in the territory controlled from its St. Louis office.

CHARLES A. SWAN has taken a position as general superintendent of the Crucible Steel Forge Co., Cleveland, Ohio.

DON M. SUTOR, formerly manager of the El Paso office of the Sullivan Machinery Co., has been appointed sales manager for the territory of Western Kentucky, Western Tennessee, Missouri, Arkansas, Oklahoma and Kansas (except the oil territory), with headquarters at Room No. 2006 Railway Exchange, St. Louis.

WALTER B. MASSEY has resigned as production manager of the Fort Wayne Oil Tank and Fuel Corp., and has returned to Watertown, N. Y., and has become associated with his brother, Frank L. Massey, in the Massey Machine Works of Watertown. Last August Mr. Massey was commissioned a captain in the 139th Engineers.

CHARLES G. GUILD has been officially announced as successor to Clayton O. Griffin as secretary and service manager of the Wayne Oil Tank and Pump Co. Mr. Guild is from the Burlington Wheel Co., Burlington, Iowa, where he held the position of manager. He was formerly manager of the Jenny Electric Light and Power Co., Fort Wayne, continuing with the General Electric Co. when a consolidation was perfected.

E. J. LUSTER, a mechanical engineer and former vice-president and general manager of the Luster-Jordon Co., Inc., Philadelphia, is now head of the Luster Machinery Co., which occupies enlarged offices in the Widener Building, Philadelphia. Over seventy-eight firms are represented in Philadelphia by this firm. The *Machinery Messenger*, a monthly magazine, is published by this company and has a large circulation among tool manufacturers and consumers.

GEORGE E. TRUNDLE, JR., formerly chief engineer of the American Multigraph Co., has opened an office as consulting engineer in the Engineers' Building, Cleveland, Ohio. Those who are at all familiar with the work done by Mr. Trundle in connection with the making of fuses during the war, and who know of the machines and methods which he devised for this work, will appreciate his qualifications for the work he is now undertaking. His accomplishments were not confined to the designing of special machinery and tools, however, but also had much to do with management, production and human relationship at a time when these were all important questions. Mr. Trundle has been retained as consulting engineer for the American Multigraph Co., who perhaps know of his work better than any one else.

Few Early Deliveries on Machine Tools

Reports of good business continue to increase and additions to shop capacity are being made by machine tool builders in different lines of work. Prompt deliveries of machine tools are becoming difficult to secure and delivery dates are further off than during the war in some cases. The demand for machinery is fortunately from many sources, and while the motor trades are probably responsible for a majority of it, there is much activity in other lines; even the railroads are beginning to order much needed machinery.

Catalogs Wanted

The Forman Christian College, Department of Physics, Lahore, India, wants to receive catalogs and other printed matter pertaining to two- and three-horse power, electrically driven, centrifugal pumps.

Export Opportunities

The Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C., has inquiries for the agencies of machinery and machine tools. Any information desired regarding these opportunities can be secured from the above address by referring to the number following each item.

A company in the Philippines having branch offices in China, Japan, and also in this country, desires to represent American manufacturers in the Far Eastern markets. References. No. 29,828.

The purchase and agency is desired by a firm in France for the sale of construction materials for buildings and factories. Correspondence should be in French. References. No. 29,846.

A firm in Italy desires to purchase concrete manufacturing machinery. Correspondence should be in Italian. Quotations should be given c.i.f. Italian port. References. No. 29,891.

A commercial agent in Switzerland desires to be placed in touch with manufacturers, with a view to securing an agency for the sale of machine tools, standard and special machinery; machinery accessories and parts, such as roller bearings, gears, and pulleys; radiators; also iron, steel, metals, and automobiles. References. No. 29,697.

A firm in Denmark desires to purchase machine tools and other equipment for building a shop to make motorcycles. Correspondence may be in English. No. 29,743.

An agency is desired by a manufacturer in Spain for the sale of cranes, elevating apparatus, gasoline, kerosene, and crude-oil engines; mining machinry; machinery for the construction of public works; steam engines; electric motors, dynamos, and electrical apparatus and supplies; complete material for aërial cableways; steel cables for traction and elevation; agricultural machinery and tractors. Correspondence should be in Spanish. References. No. 29,784.

A firm in Italy desires to secure an agency for the sale of machinery and machine tools. Correspondence may be in English. No. 29,794.

The purchase is desired by a firm in Spain of a leather-pressing machine, described as a frame mounting two heavy cylindrical rolls for ironing oak-tanned heavy sole leather, the pressure being regulated by a screw adjustment. Quotations should be given f.o.b. American port, with an indication of freight rate and date of delivery. Correspondence should be in Spanish. References. No. 29,795.

A Belgian company desires the agency for the sale of machine tools, lathes, grinding and drilling machines, taps, bits, chucks and all machinists' supplies. References. No. 30,038.

Trade Catalogs

How to Run a Lathe. South Bend Lathe Works, South Bend, Ind. Catalog No. 19; 5 x 7 in. This catalog is valuable as a textbook for apprentices in the large industrial plants and for students taking machine-shop work in vocational, industrial and manual training schools; it is also published in the Spanish and Portuguese languages. A copy of this little book will be mailed, post-paid, to any address for 10 cents, coin or stamps.

Pangborn Sandblasts and Allied Equipment. Pangborn Corporation, Hagerstown, Md. Catalog, pp. 24, 4 x 9 in. This catalog has been condensed so as to show its various types and sizes of sandblasts. It also gives a brief description of the individual features and capacities of the different units. Detailed information and data will be sent upon request.

Rego Welding and Cutting Apparatus. The Bastian-Blessing Co., West Austin Ave. at La Salle St., Chicago, Ill. Catalog; pp. 36; 8 x 11 in. This catalog describes the company's welding and cutting apparatus in detail, giving prices, etc. Many illustrations are shown.

Presses. Ferracute Machine Co., Bridgeton, N. J. Catalog No. 21; pp. 396; 6 x 9 in.; bound in cloth. This catalog describes and illustrates the various presses made by the Ferracute Machine Co. and is divided into a number of sections, as follows: Cutting presses; drawing presses; embossing presses; foot presses; gravity presses; punching presses; stamping presses and various attachments, odd machines, etc. The book gives dimensions, data, etc., in regard to the various presses made by this company and contains much information of value to press users. The catalog is also arranged so that any individual section can be sent to a user of any particular type of press.

The Carbo-Hydrogen Co. of America, Benedum-Trees Building, Pittsburgh, Penn. Catalog, 6¼ x 9 in.; 27 pages, illustrated; describes the use of Carbo-Hydrogen apparatus for cutting steel and wrought iron.

Forthcoming Meetings

American Foundrymen's Association. Annual convention and exhibit will be held in Philadelphia the week of Sept. 29, 1919. C. E. Hoyt, secretary, 111 W. Monroe St., Chicago, Ill.

The American Steel Treaters' Society will hold its annual convention and exhibition at the Seventh Regiment Armory, Chicago, Ill., Sept. 1. Al. J. Murphy, 154 East Erie St., Chicago, Ill., is chairman of the exhibit committee.

Boston Branch, National Metal Trades Association. Monthly meeting on first Wednesday of the odd months. George D. Berry, secretary, room 50-51, 166 Devonshire St., Boston, Mass.

Electric Hoist Manufacturers' Association. Monthly meetings at the offices of the Yale & Towne Manufacturing Co., 9 East 40th St., New York City. Secretary, W. C. Briggs, Shepard Electric Crane and Hoist Co.

Engineers' Club of Philadelphia. Regular meeting the third Tuesday of the month with the exception of July and August. Lewis H. Kenney is the chairman of committee on papers.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

The International Railroad Master Blacksmith's Association will hold its annual convention in Chicago Aug. 19, 20 and 21. The location of the meeting in Chicago will be announced later.

Philadelphia Foundrymen's Association. Meeting first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn., Howard Evans, secretary, Pier 45, North Philadelphia, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 547 Arnett Boulevard, Rochester, N. Y.

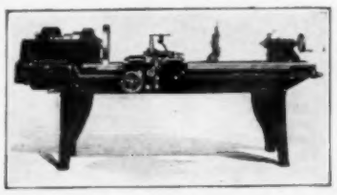
Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Lathe, Light Pattern Engine

Sidney Machine Tool Co., Sidney, Ohio.

"American Machinist," July 24, 1919



Actual swing over vees, 14½ in.; actual swing over carriage, 9¼ in.; tailstock spindle travel, 5½ in.; tailstock diameter, 1⅞ in.; taper of centers, No. 3 Morse; front-spindle bearing, 2½ x 4¼ in.; rear-spindle bearing, 1¾ x 2¾ in.; hol through spindle, 1¼ in.; counter cone pulley diameters, 9, 7½, 6 in.; width of driving belt, 3 in; first back gear ratio, 2.9 to 1; second back gear ratio 12.7 to 1; countershaft friction pulley, 10 x 3½ in.; countershaft speed, 200 r.p.m.; countershaft speed of reverse, 160 r.p.m.; threads and feed changes, plain change feed box, 4.6 to 74; threads and feed changes, quick-change feed box, 4.6 to 148; range of threads, plain-change feed box, 2 to 32; range of threads, quick-change gear box, 2 to 64; steadyrest takes in, 4½ in.; size of tool, ⅝ x 1¼ in.; weight 6-ft bed, 1750 lb.; weight additional 2 ft., 100 pounds.

Toolpost, Elevating

Skelton Tool Co., 406-408 Ash St., Syracuse, N. Y.

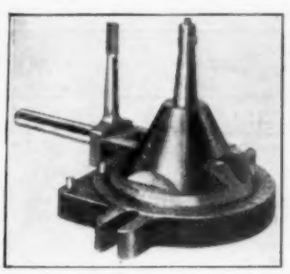
"American Machinist," July 24, 1919

It is claimed that this toolpost will grip a lathe tool or boring bar without marring and that it provides a firm seat without any tendency to bend the tool. The post swings through a complete circle and is clamped independently of the tool-clamping screws. The elevating mechanism is entirely separate from the swivel clamp and gives over 1 in. of vertical adjustment. The front part has a dovetailed slide, by means of which it is fastened to the main part of the post, two screws being used to lock it firmly in place. Where it is desired to use boring bars a second block is placed in the bottom of the toolholder slot having a V-shaped groove in the top.

Dresser, Emery Wheel

Otto A. Miller, 169 Edgervale Ave., Detroit, Mich., manufacturer; J. R. Stone Tool and Supply Co., 997 Woodward Ave., Detroit, Mich., sales agents.

"American Machinist," July 24, 1919

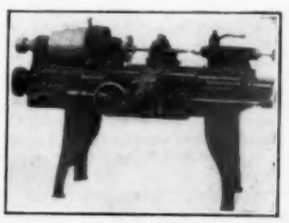


A holder carried on a swivel base by a cross-side enables the operator to set the diamond to form any radius desired. The radial distance is measured from the measuring post shown which is set 3 in. from the center of the base. The slide has three splines so that the toolpost may be set at right angles when desired. A vertical adjustment is provided. The base is graduated to 5 min. of arc. The fixture may be used for light radius turning on milling machines where the work is held in the milling chuck.

Lathe, Manufacturing 16-Inch

Chard Lathe Co., Newcastle, Ind.

"American Machinist," July 24, 1919

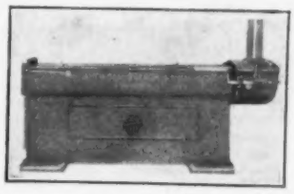


The spindle is provided with a friction clutch which engages with the cone pulley, thus eliminating the necessity of overhead countershaft control. The clutch-operating lever also works a brake which stops the spindle. The lever which moves the tailstock spindle also clamps it. The carriage is fitted with automatic stops. For repetition work, the lathe is provided with a large micrometer dial on the crossfeed screw, heavy-duty tool blocks, multiple crossfeed stops and multiple length feed stops. If desired the machine may be equipped for screw cutting. The following additional equipment can be furnished: Double tool block, compound rest, turret tool block, taper attachment, draw chuck, pump pan and piping for coolant.

Broaching Machine, No. 1½

American Broach and Machine Co., Ann Arbor, Mich.

"American Machinist," July 24, 1919



Bore in face of machine, 5 in. diameter; size of face (finished), 13½ in. wide, 12 in. high; size of face (finished) on column, 7½ in wide, 18½ in. high; capacity to cut keyways up to ¾ in. and square and spline holes up to 1 in.; standard equipment furnished with machine, one each 1½-, 2- and 2½-in. reducing bushings to fit bore in face of machine, one each ⅝-, ¾-, ⅞- and 1-in. threaded pull bushings; height from hole to center of bore in face of machine, 30¾ in.; stroke of pulling head suitable to operate broaches up to 50 in. long; pulling screw of buttress thread type 4-pitch, operated by special bronze nut; speed of pulley on machine 680 r.p.m., 14-in. diameter; belt 2½in. light double; speed of countershaft, 680 r.p.m.; belt, 3½-in.; travel of pulling head, 90 in. per minute; reverse of pulling head, 180 in. per minute; weight of machine (crated—domestic) with countershaft, 1975 pounds.

Boring Bar

Skelton Tool Co., 406-408 Ash St., Syracuse, N. Y.

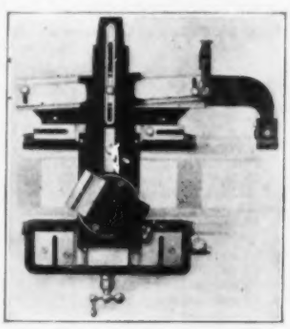
"American Machinist," July 24, 1919

The chief advantage claimed for this is its extreme rigidity due to the fact that the bar itself is about three-quarters the diameter of the smallest hole it will bore. The boring end is so constructed that it is very easily ground without changing the shape of the cutting edge. Due to the shape of the cutting part of the bar, its life is considrably greater than that of the ordinary forged bar. Boring tools up to 1 in. in diameter are made of high-speed steel, electrically welded to a low-carbon steel shank, while sizes over 1 in. have a high-speed head separate from the bar and interchangeable with other sizes of heads.

Taper Attachment for Lathes

Lehmann Machine Co., 606 S. Broadway, St. Louis, Mo.

"American Machinist," July 24, 1919

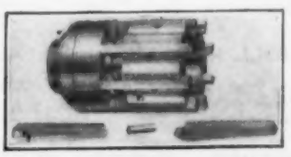


This taper attachment is being built as a special attachment for the company's lathes. Has a rigid and direct connection between the cross and taper slides. Capscrews are used to lock the attachment to the cross-slide or to release it in the usual manner. The end of the adjustable slide is graduated to indicate taper in inches per foot. The adjusting screw at the end of the slide is so made as to give approximately 15 deg. of taper for each full turn of the screw. To use cams the taper slide and shoe are removed. The cam to be used is fastened to the lower roller or stationary slide, and the cam roller is held by a screw through the long slot in the extension arm.

Reamers, Expansion

Davis Boring Tool Co., 3722 Forest Park Blvd., St. Louis, Mo.

"American Machinist," July 24, 1919



The blades are renewable and may be replaced when worn out. Wearing parts are hardened, and all threaded parts are protected. The blades are controlled by a micrometer adjustment dial graduated in quarter-thousandths. The blades are slotted to fit over the ring of the adjusting dial and are secured by the hardened and ground taper pins which fit between the reamer body and a groove in the blades, giving a constant downward and lateral holding thrust. These reamers are made in all sizes between 1⅛ in. and 6 in. and range from six blades for the smallest up to 12 blades for the largest. They are made in three types; sheil, straight shank, and taper shank.

Patented Aug. 20, 1918

The Weekly Price Guide of

IRON AND STEEL

PIG IRON—Quotations compiled by The Matthew Addy Co., as per Department of Commerce Committee Schedule.

CINCINNATI	
No. 2 Southern	$29.80
Northern Basic	27.55
Southern Ohio No. 2	28.55
NEW YORK—TIDEWATER DELIVERY	
Penna. 2X	31.90
Virginia No. 2	31.15
Southern No. 2	33.95
BIRMINGHAM	
No. 2 Foundry	25.75
PHILADELPHIA	
Eastern Pennsylvania No. 2	30.65
Virginia No. 2	30.85
Basic	29.90
Grey Forge	29.90
Bessemer	31.85
CHICAGO	
No. 2 Foundry local	26.75
No. 2 Foundry, Southern	33.00
PITTSBURGH, INCLUDING FREIGHT CHARGE FROM VALLEY	
No. 2 Foundry	28.15
Basic	27.15
Bessemer	29.35

STEEL SHAPES—The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	New York Current	New York One Month Ago	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
Structural shapes	$3.47	$4.07	$4.15	$3.37	$4.20	$3.47	$4.20
Soft steel bars	3.37	3.97	4.45	3.27	4.20	3.37	4.10
Soft steel bar shapes	3.37	3.97	4.45	3.27	4.20	3.37	4.10
Soft steel bands	4.07	4.57	4.995				
Plates, ¼ to 1 in. thick	3.67	4.27	4.495	3.57	4.20	3.67	4.45

Note—For less than carload lots add 4¼c. per 100 lb.

BAR IRON—Prices per 100 lb. at the places named are as follows:

	Current	One Year Ago
Mill, N. Y.	$2.62	$3.50
Warehouse, New York	3.37	4.70
Warehouse, Cleveland	3.22	4.10
Warehouse, Chicago	3.37	4.10

STEEL SHEETS—The following are the prices in cents per pound from jobbers' warehouse at the cities named:

	Pittsburgh, Mill, in Carloads	New York Current	New York One Month Ago	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
*No. 28 black	4.35	5.50	5.62	6.495	5.27	6.42	5.37	6.52
*No. 26 black	4.25	5.40	5.52	6.395	5.17	6.32	5.27	6.42
*Nos. 22 and 24 black	4.20	5.35	5.47	6.345	5.12	6.27	5.22	6.37
Nos. 18 and 20 black	4.15	5.30	5.42	6.295	5.07	6.22	5.17	6.32
No. 16 blue annealed	3.75	4.77	4.77	5.695	4.67	5.62	4.77	5.72
No. 14 blue annealed	3.65	4.67	4.67	5.595	4.57	5.52	4.67	5.62
No. 10 blue annealed	3.55	4.57	4.57	5.495	4.47	5.47	4.57	5.52
*No. 28 galvanized	5.70	7.20	7.42	7.745	6.62	7.67	6.97	7.77
*No. 26 galvanized	5.40	6.90	7.12	7.445	6.32	7.37	6.67	7.47
No. 24 galvanized	5.25	6.75	6.97	7.295	6.17	7.22	6.52	7.32

* For painted corrugated sheets add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets add 15c.; all gages.

COLD DRAWN STEEL SHAFTING—From warehouse to consumers requiring at least 1000 lb. of a size (smaller quantities take the standard extras) the following discounts hold:

	Current	One Year Ago
New York	List	List plus 13%
Cleveland	5% off	List plus 13%
Chicago	2% off	List plus 13%

DRILL ROD—Discounts from list price are as follows at the places named:

	Extra	Standard
New York	45%	40%
Cleveland	35%	35%
Chicago	35%	35%

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots is:

	Current	One Year Ago
New York	$21.00–26.00	$15.00–19
Cleveland	20.00	20.00
Chicago	16.50	19.00

In coils an advance of 50c. usually is charged.
Domestic iron (Swedish analysis) is selling at 15c. per lb.

WELDING MATERIAL (SWEDISH)—Prices are as follows in cents per pound f.o.b. New York, in 100 lb. lots and over:

Welding Wire		Cast-Iron Welding Rods	
1/16, 3/32, 1/8, 5/32, 3/16 No. 8, 7/32 and No. 10	21.00 to 30.00	1/16 by 12 in. long	14.00
No. 12		1/8 by 19 in. long	12.00
5/32, No. 14 and 1/4		3/16 by 19 in. long	10.00
No. 18		1/4 by 21 in. long	10.00
No. 20		Special Welding Wire, Coated	
		1/8	33.00
		5/32	30.00
		1/4	38.00

Domestic 20c. for 1/16, 15c. for 1/8 to 3/16.

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York Current	Cleveland Current	Chicago Current
Openhearth spring steel (heavy)	7.00	8.00	8.00
Spring steel (light)	10.00	11.25	11.75
Coppered bessemer rods	8.00	8.00	7.07
Hoop steel	4.07	4.75	4.07
Cold-rolled strip steel	8.40	8.25	8.10
Floor plates	5.67	6.00	5.92

Note—For less than carload lots add 4½c. per 100 lb.

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh: basing card of National Tube Co. for steel pipe, Cardry A. M. Byer's Co. for iron, both dated Mar. 21, 1919.

BUTT WELD

Inches	Steel Black	Steel Galvanized	Inches	Iron Black	Iron Galvanized
1/8, 1/4 and 3/8	50%	24%	1/8 to 1 1/4	39%	23%
1/2	54%	40%			
3/4 to 3	57%	44%			

LAP WELD

2	50%	35%	2	32%	18%
2½ to 6	53%	41%	2½ to 6	34%	21%

BUTT WELD, EXTRA STRONG PLAIN ENDS

1/8, 1/4 and 3/8	46%	29%	1/8 to 1 1/4	39%	24%
1/2	51%	39%			
3/4 to 1 1/4	55%	43%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	48%	37%	2	33%	20%
2½ to 4	51%	40%	2½ to 4	35%	23%
4½ to 6	50%	39%	4½ to 6	34%	22%

Stock discounts in cities named are as follows:

	New York Black	New York Galvanized	Cleveland Black	Cleveland Galvanized	Chicago Black	Chicago Galvanized
⅛ to 3 in. steel butt welded	47%	31%	43½%	34½%	57½%	44%
2½ to 6 in. steel lap welded	42%	27%	45½%	30½%	53½%	41%

Malleable fittings. Class B and C, banded, from New York stock sell at list 2% off. Cast iron, standard sizes, 20% off.

METALS

MISCELLANEOUS METALS—Present and past New York quotations in cents per pound, in carload lots:

	Current	One Month Ago	One Year Ago
Copper, electrolytic	24.00	15.37½	26.00
Tin in 5-ton lots	70.00	72.50	94.00
Lead	6.00	5.25	5.05
Spelter	8.00	6.05	8.62½
ST. LOUIS			
Lead	5.75	5.00	7.75
Spelter	7.65	6.20	8.37½

At the places named, the following prices in cents per pound prevail, for 1 ton or more:

	New York Current	New York One Month Ago	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
Copper sheets, base	32.50	22.50	42.00	34.50–36.50	38.00	36.50	33.00
Copper wire (carload lots)	28.25	23.00–28	47.50	30.50	35.00	25.00	33.50
Brass sheets	25.00	23.75–28	39.125	33.00	37.00	28.00	31.50
Brass pipe	35.50	34.00–37	39.00	39.00	40.00	37.00	41.50
Solder (half and half) (case lots)	45.00	46.50–41	45.00	41.00	62.00	38.50	70.00

Copper sheets quoted above hot rolled 16 oz., cold rolled 14 oz. and heavier, add 1c.; polished takes 1c. per sq.ft. extra for 20-in. widths and under; over 20 in., 2c.

BRASS RODS—The following quotations are for large lots, mill. 100 lb. and over, warehouse; net extras:

	Current	One Year Ago
Mill	$21.25	$32.25
New York	24.25	34.25
Cleveland	30.00	35.00
Chicago	30.00	29.50

Shop Materials and Supplies

ZINC SHEETS—The following prices in cents per pound prevail:

Carload lots f. o. b. mill 11.00

	In Casks		Broken Lots	
	Current	One Year Ago	Current	One Year Ago
Cleveland	12.95	18.75	13.30	18.40
New York	12.00	16.50	13.00	17.00
Chicago	16.50	22.00	16.00	21.50

ANTIMONY—Chinese and Japanese brands in cents per pound, in ton lots, for spot delivery, duty paid:

	Current	One Year Ago
New York	8.37½	13.35
Chicago	10.50	13.50
Cleveland	10.75	16.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York		Cleveland		
	Current	One Year Ago	Current	One Year Ago	Chicago
Copper, heavy and crucible	16.75	23.50	19.00	24.00	20.00
Copper, heavy and wire	15.75	22.50	18.00	23.00	19.50
Copper, light and bottoms	13.50	20.50	17.00	21.00	18.50
Lead, heavy	4.62½	7.00	5.25	7.00	5.125
Lead, tea	3.75	5.25	4.00	5.50	4.00
Brass, heavy	10.00	14.75	14.00	16.50	19.00
Brass, light	8.00	11.00	11.00	12.50	11.50
No. 1 yellow brass turnings	9.00	13.00	12.00	14.00	12.00
Zinc	4.25	6.25	5.50	6.50	5.75

ALUMINUM—The following prices are from warehouse at places named:

	New York	Cleveland	Chicago
No. 1 aluminum, 98 to 99% pure, in ingots for remelting (1-15 ton lots), per lb	33c.	32.00c.	33½c.

COPPER BARS from warehouse sell as follows in cents per pound, for ton lots and over:

	Current	One Year Ago
New York	27.00	42.00
Chicago	28.00	38.00
Cleveland	35.00	36.50

BABBITT METAL—Warehouse price per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	90.00	125.00	80.00	108.00	75.00	100.00
Commercial	50.00	70.00	18.50	23.00	15.00	24.00

SHOP SUPPLIES

New Yerk prices will be revised in next weeks issue.

NUTS—From warehouse at the places named, on fair-sized orders, the following amount is deducted from list:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Hot pressed square	$1.50	+$2.50	$2.25	$1.40	$2.00	$1.05
Hot pressed hexagon	1.50	+2.50	2.25	1.20	2.00	.85
Cold punched hexagon	1.50	+2.50	2.25	.75	1.30	1.00
Cold punched square	1.50	+2.50	2.25	.75	1.30	1.00

Semi-finished nuts sell at the following discounts from list price:

	Current	One Year Ago
New York	50-10%	40%
Chicago	50%	50%
Cleveland	60-10-10%	60%

MACHINE BOLTS—Warehouse discounts in the following cities:

	New York	Cleveland	Chicago
½ by 4 in. and smaller	50%	50%	50-10%
Larger and longer up to 1¼ in. by 30 in.	40%	40%	40-10%

WASHERS—From warehouses at the places named the following amount is deducted from list price:

For wrought-iron washers:

New York.....$1.25 Cleveland.....$3.75 Chicago.....$2.25

For cast-iron washers the base price per 100 lb. is as follows:

New York.....$6.00 Cleveland.....$3.75 Chicago.....$4.00

CARRIAGE BOLTS—From warehouses at the places named the following discounts from list are in effect:

	New York	Cleveland	Chicago
½ by 6 in. and smaller	45-5%	40-5%	50%
Larger and longer up to 1 in. by 30 in.	35%	37½%	50-5%

COPPER RIVETS AND BURS sell at the following rate from warehouse:

	Rivets		Burs	
	Current	One Year Ago	Current	One Year Ago
Cleveland	20%	List plus 10%	10%	List plus 10%
Chicago	20%	List price	20%	List price
New York	40%	20% from list	20%	10½% from list

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ½ and smaller	50-10%	60%	45%
Tinned	50-10%	60%	40%

Boiler, ½, ¾, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York...$5.25 Cleveland...$4.00 Chicago....$4.87 Pittsburgh...$4.65

Structural, same sizes:

New York...$5.35 Cleveland...$4.10 Chicago ...$4.97 Pittsburgh...$4.75

MISCELLANEOUS

SEAMLESS DRAWN TUBING—The base price in cents per pound from warehouse in 100-lb. lots is as follows:

	New York	Cleveland	Chicago
Copper	34.00	39.00	38.50
Brass	33.00	39.00	37.00

For immediate stock shipment 3c. is usually added. The prices, of course, vary with the quantity purchased. For lots of less than 100 lb., but not less than 75 lb., the advance is 2c.; for lots of less than 75 lb., but not less than 50 lb., the advance is 5c. over base (100-lb. lots); for less than 50 lb., but not less than 25 lb., 10c. should be added to the base price; and for quantities of from 10 to 25 lb. the extra is 25c.; less than 10 lb., add 35c.

Double above extras will be charged for angles, channels and sheet-metal mouldings if ordered in above quantities. The above extras also apply to brass rod other than standard stock sizes—stock sizes being considered as ¼ up to 2 in. inclusive in rounds, and ¼ up to 1½ in., inclusive in square and hexagon—all varying by thirty-seconds up to 1 in. and by sixteenths over 1 in. On all shipments aggregating less than 100 lb. there is usually a boxing charge of $1.50.

LONG TERNE PLATE—For No. 28 primes, from Stock, the price in Chicago is $7.50 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	13.00	11.00-13.00	14.00	11.00 to 14.00
Colored mixed	9.00 to 12.00	8.50-12.00	11.00	9.50 to 12.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13¼ x 13½	13½ x 20½
Cleveland	52.00	58.00
Chicago	41.00	43.50

SAL SODA sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$1.75	$1.75	$1.75
Philadelphia	1.75	1.75	1.75
Cleveland	2.75	2.75	2.40
Chicago	2.00	2.00	2.25

ROLL SULPHUR in 360-lb. bbl. sells as follows per 100 lb.:

	Current	One Month Ago	One Year Ago
New York	$3.65	$3.65	$4.30
Cleveland	3.62	3.62	4.60
Chicago	4.12½	4.50	4.00

COKE—The following are prices per net ton at ovens, Connellsville, and cover the past five weeks:

	July 17	July 10	July 3	June 26	June 19
Prompt furnace	$4.00	$4.25	$4.25	$4.00	$4.00
Prompt foundry	5.00	5.00	5.00	4.50	4.50

FIRE CLAY—The following prices prevail:

		Current
Ottawa, bulk in carloads	per ton	$8.00
Cleveland	375-lb. bag	2.50

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Raw in barrels (5 bbl. lots)	$2.15	$1.86	$2.15	$2.00	$2.48	$1.97
5-gal. cans	2.28	1.96	2.40	2.15	2.68	2.17

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Year Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	13.00	14.50	14.00	14.50	13.00	14.00
25 and 50-lb. kegs	13.25	14.75	14.25	12.75	13.25	14.25
12½-lb. keg	13.50	15.00	14.50	15.00	13.50	14.50
5-lb. cans	15.00	16.50	.....	.....	15.00	16.00
1-lb. cans	16.00	17.50	.....	.....	16.00	17.00

500 lb. lots less 10% discount; 2000 lb. lots less 10-2½% discount.

NEW *and* ENLARGED SHOPS

Consult the Buying Section when in need of machinery or supplies

Metal Working

NEW ENGLAND STATES

Conn., Hartford—The Arrow Electric Co., 99 Hawthorne St., has awarded the contract for a 2 story, 50 x 200 ft. addition to its factory. Estimated cost, $40,000. Noted July 31.

Conn., Meriden—The M. B. Schenck Co., Center St., manufacturer of hardware, plans to build a 2 story, 53 x 64 ft. addition to its factory. Estimated cost, $22,000.

Conn., New Britain—The Hart & Hutchinson Co., Corbin Ave., manufacturer of steel cabinets, has awarded the contract for the erection of a 1 story, 77 x 340 ft. addition to its plant. Estimated cost, $70,000. Noted July 24.

Conn., Rockville—J. Zaugg, 73 Talcott Ave., plans to build a 1 story garage and sales room. Estimated cost, $25,000.

Mass., East Springfield (Springfield P. O.)—The Springfield Tool Co., Inc., 125 Dwight St., Springfield, will build a 1 and 2 story, 90 x 200 ft. factory and office, here. Estimated cost, $55,000.

Mass., Taunton—The L. C. Blanke Twist Drill Co., Grosvenor St., has awarded the contract for a 1 story, 40 x 115 ft. addition to its factory. Estimated cost, $14,000.

Mass., Worcester—F. W. Grimley, 126 Piedmont St., will build a 1 story, 55 x 120 ft. garage at 385 Pleasant St. Estimated cost, $20,000. E. T. Chapin, 340 Main St., Arch.

Mass., Worcester—Kaplan & Kritzman, 19 Columbia St., will build a 1 story, 65 x 74 ft. garage on Pleasant St. Estimated cost, $20,000. E. T. Chapin, 340 Main St., Arch. Noted July 24.

Mass., Worcester—The Worcester Paper Box Co., 11 Houchin Ave., is having plans prepared by S. H. Pitcher Co., 44 Front St., for a 3 story, 50 x 150 ft. garage, to be erected on Austin St. Estimated cost, $60,000. Noted July 31.

R. I., Cranston (Providence P. O.)—The Kenney Manufacturing Co., 154 Greenwood St., manufacturer of metal novelties, has awarded the contract for a 1 story, 60 x 145 ft. and 20 x 60 ft. addition to its plant, to be erected on Wellington St. Estimated cost, $25,000.

R. I., Cranston (Providence P. O.)—The United Wire and Supply Co. has awarded the contract for the erection of a 2 story, 100 x 120 ft. and 50 x 250 ft. addition to its plant. Estimated cost, $125,000.

R. I., Providence—The Apco Manufacturing Co., 702 Eddy St., manufacturer of automobile supplies, has awarded the contract for the erection of a 1 story, 80 x 200 ft. addition to its factory. Estimated cost, $30,000.

MIDDLE ATLANTIC STATES

N. J., Camden—J. B. Van Sciven, c/o Peuchert & Wunder, Arch., 310 Chestnut St., Philadelphia, Penn., has awarded the contract for a 1 story, 82 x 89 ft. garage, to be erected at 110-118 Arch St., here. Estimated cost, $20,300.

N. J., Irvington (Newark P. O.)—The Jennings Silver Co., 390 Nye Ave., has awarded the contract for the erection of a 2 story, 40 x 90 ft. factory. Estimated cost, $10,000.

N. Y., Buffalo—The Buffalo Forge Co., 212 Mortimer St., plans to build an addition to its factory. Estimated cost, $14,000.

N. Y., Carthage—The Northwestern Telephone Corporation, 301 State St., has purchased a site on North Mechanic and Spring St., and will build a 2 story, 22 x 28 ft. machine shop and storehouse and a 1 story, 25 x 50 ft. garage. Estimated cost, between $18,000 and $25,000.

N. Y., Cornell (East Freedom P. O.)—The Standard Oil Co., 26 Broadway, New York City, has awarded the contract for a 2 story, 46 x 52 ft. garage and office, to be erected here.

N. Y., New York (Borough of Brooklyn)—Coyne & Delaney, 832 Kent Ave., will build a 3 story, 50 x 120 ft. factory on Flushing and Mt. Olivet Ave., for the manufacture of plumbing materials. Estimated cost, $70,000.

N. Y., New York (Borough of Brooklyn)—P. Glickman, 44 Court St., will build a 1 story, 100 x 160 ft. garage on President St. and Franklin Ave. Estimated cost, $40,000.

N. Y., New York (Borough of Brooklyn)—M. Liebowitz, 741 Howard Ave., will build a 1 story, 85 x 85 ft. garage on Sheffield Ave. and New Lots Rd. Estimated cost, $12,000.

N. Y., New York (Borough of Brooklyn)—D. Norton, 301 Douglas St., will build a 1 story, 60 x 100 ft. garage, at 357 Douglas St. Estimated cost, $25,000.

N. Y., New York (Borough of Brooklyn)—J. S. Silman, 1511 Emmons Ave., will build a 1 story, 110 x 125 ft. garage on Bridge St. and Willoughby Ave. Estimated cost, $25,000.

N. Y., New York (Borough of Manhattan)—T. G. Cowan, 125 West 53rd St., is having plans prepared by W. J. Russell, Arch., 73 West 46th St., for alterations to his 5 story, 40 x 200 ft. garage. Estimated cost, $25,000.

N. Y., New York (Borough of Manhattan)—The Hillman Co., 567 3rd Ave., will build a 1 story, 99 x 120 ft. garage at 237-245 East 41st St. Estimated cost, $25,000. Noted June 5.

N. Y., New York (Borough of Manhattan)—The West 50th St. Garage Corporation, 412 West 38th St., has awarded the contract for a 2 story, 50 x 105 ft. garage, to be erected at 540-542 West 52nd St. Estimated cost, $20,000. Noted July 3.

N. Y., New York (Borough of Queens)—S. Blickman, 199 Lafayette St., New York City, manufacturer of heavy sheet metal, has awarded the contract for a 6 story, 132 x 200 ft. factory, to be erected on Nott, Manby, Anable and Mount St., Long Island City. Estimated cost, $400,000. Noted July 10.

N. Y., Syracuse—The M. L. Oberdorfer Brass Co., 804 East Water St., has had plans prepared for a 1 story foundry. Estimated cost, $40,000. M. L. King, Arch., Snow Bldg., will receive bids until Aug. 25.

N. Y., Watertown—F. G. Hall, 823 Boyd St., has purchased the Black River Bakery, State St., and plans to convert same into a machine shop.

Penn., Philadelphia—The Bernstein Manufacturing Co., American and Allegheny St., manufacturer of beds, will build a 3 story, 52 x 152 ft. factory. A. J. Sauer & Co., Denckla Bldg., Arch.

Penn., Philadelphia—The Dodge Steel Co., Tacony St., has awarded the contract for a 1 story, 116 x 800 ft. foundry.

Penn., Philadelphia—The Northern Liberties Realty Co., 521 North Orianna St., has awarded the contract for the erection of a 1 story, 70 x 100 ft. garage. Estimated cost, $10,000. Noted Apr. 3.

Penn., Pittsburgh—The Pittsburgh Gage and Supply Co., 30th and Liberty St., will build a 6 story, 98 x 130 ft. addition to its factory for the manufacture of washing machines, vacuum sweepers, etc. W. G. Wilkins Co., Westinghouse Bldg., Arch.

SOUTHERN STATES

Ky., Louisville—The W. C. Krauth Electric Co., 113 West Market St., will build an addition to its plant. Estimated cost, $20,000.

MIDDLE WEST

Ill., Chicago—W. Bergstrom, 935 West 59th St., will build a 1 story, 50 x 125 ft. garage on West 59th and Green St. Estimated cost, $17,500.

Ill., Chicago—Ryan Bros., 847 South Racine Ave., will build a 1 and 2 story, 90 x 95 ft. garage. Estimated cost, $15,000. C. E. Frazier, 30 North Dearborn St., Arch.

Mich., Detroit—The Commerce Motor Car Co., Solvay and Mackie Ave., has awarded the contract for the erection of a 1 story, 120 x 240 ft. factory, for the manufacture of automobile trucks. Noted April 10.

Mich., Detroit—The Fruehauf Trailer Co., 1371 Gratiot Ave., is having plans prepared by Stahl & Kinsey, Arch., McKerchey Bldg., for a 1 and 2 story, 100 x 260 ft. factory, to be erected near the Detroit Terminal R.R. and Dequindre St. Estimated cost, $100,000.

Mich., Detroit—The General Motors Corporation, Boyer Campbell Bldg., is building a plant. Estimated cost, $11,000,000. Noted June 12.

Mich., Detroit—The Swedish Crucible Steel Co., Butler and Grand Trunk Ry., will build a 1 story, 240 x 240 ft. factory on Conant Ave. Raseman & Freer, 1302 Penobscot Bldg., Arch. Noted July 17.

Mich., Detroit—J. Wynne, Jr., 721 Ford Bldg., is having plans prepared by G. W. Graves, Arch., 43 John R St., for a 2 story, 60 x 140 ft. garage, to be erected on Grand River Ave. Estimated cost, $55,000.

Ohio, Cleveland—The Atlantic Foundry Co., 7510 Morgan Rd., has awarded the contract for the erection of a 1 story, 26 x 36 ft. addition to its foundry. Estimated cost, $5000.

Ohio, Cleveland—G. E. Bell, 3045 Carnegie Ave., manufacturer of automobile bodies, has awarded the contract for a 2 story, 26 x 72 ft. addition to its plant. Estimated cost, $10,000. Noted July 24.

Ohio, Cleveland—The Colburn Machine Tool Co., 1041 Ivanhoe Rd., plans to build a 192 x 238 ft. factory. Estimated cost, $100,000.

Ohio, Cleveland—The Cuyahoga Galvanizing Co., 1280 East 59th St., has purchased a site at 3352 Payne Ave., and plans to build a 1 story, 60 x 100 ft. factory. Estimated cost, $10,000.

Ohio, Cleveland—The Dickey Grabler Manufacturing Co., 10302 Madison Ave., plans to build a 1 story, 69 x 220 ft. machine shop. Estimated cost, $50,000.

Ohio, Cleveland—The P. A. Gier Co., 5112 St. Clair Ave., has awarded the contract for a 2 story, 60 x 220 ft. machine shop, to be erected at 534 East 105th St. Estimated cost, $75,000. Noted July 31.

Ohio, Cleveland—The Grant Motor Car Co., East 131st St. and Kerby Ave., plans the erection of a 2 story, 63 x 262 ft. addition to its plant. Estimated cost, $75,000.

Ohio, Cleveland—F. M. Iler, 6607 St. Clair Ave., has had plans prepared for a 1 story, 35 x 65 ft. factory, to be erected at 1027 East 66th St., for light machine work. Estimated cost, $5000.

Ohio, Cleveland—The Johanek Tool and Manufacturing Co., 2461 East 13th St., has awarded the contract for the erection of a 2 story, 38 x 52 ft. addition to its plant. Estimated cost, $6000. Noted July 24.